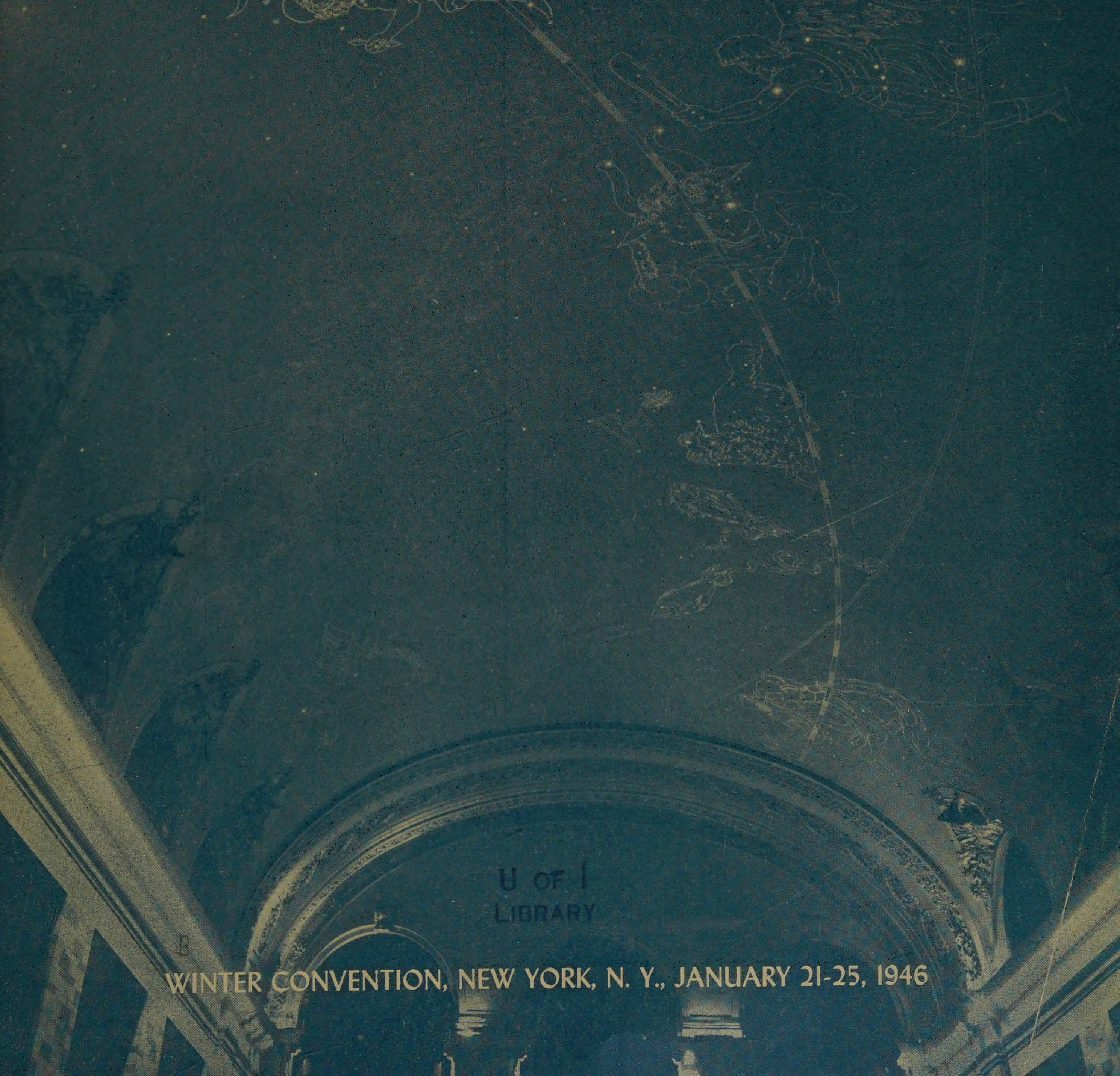
ELECTRICAL ENGINEERING

JANUARY 1946



WINTER CONVENTION, NEW YORK, N. Y., JANUARY 21-25, 1946

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JANUARY
1946

The Cover: A panorama depicting the stars of the winter heavens, recently restored on the new ceiling of Grand Central Terminal, New York, N. Y. The stars are shown in proper relative brightness by means of small rods of Lucite suspended below the lamps.

DuPont photo

TRANSACTIONS SECTION

(Follows EE page 56; a preprint of pages 1–40 of the 1946 volume. Any discussion of these papers will appear in the June 1946 "Supplement to Electrical Engineering—Transactions Section" and in the 1946 volume.)

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VOLUME 65
NUMBER 1

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Magneto	453	Telegraph printers	3
Sound-powered	405	Field wire (miles)	780

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There are authorized in an infantry division 47,524 pieces of signal equipment. In combat operations, this amount is increased from 50 to 100 per cent, depending upon the tactical operation involved. The major items of this equipment are shown in Table I.

Signal Corps photo

Figure 1. Radio set SCR-300 in use

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The vehicular-mounted frequency-modulated sets used in an infantry division are of two general types. The SCR-610, shown in Figure 2, is a low-power 14-tube set designed to provide two-way voice communication over short distances. The range of this set is from 3 to 5 miles. Two models of these sets are used, the difference being only in the frequency range. One set used by the reconnaissance troop and tank battalions operates on preset channels in the frequency range from 20.0 to 27.9 megacycles. The other set, used by the artillery and tank destroyer units, operates in the frequency range from 27.0 to 38.9 megacycles. These sets operate on either one of two channels within the frequency range. The change to either of the two preset frequencies is made by a channel switch mounted on the front panel. There are available 120 plug-in crystals in the range from 27.0 to 38.9 megacycles, and 80 crystals in the range from 20.0 to 27.9 megacycles. The frequency separation between channels is 100 kilocycles. The power supply for these sets is provided by either dry batteries or a power supply

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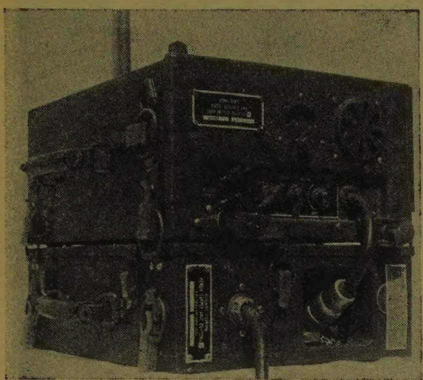

Figure 2. Radio set SCR-610, a 2-channel frequency-modulated vehicular set

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Four types of radio sets for both 2-way voice and continuous-wave communication are used in an infantry division. The type numbers, with general characteristics of each, are shown in Table II. The ranges shown are approximate because the range will vary considerably, depending upon terrain and atmospheric conditions.

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The telegraph printer sets used in the division are identical with commercial teletypewriters, with the addition of a portable power unit to adapt them to field operations. The power unit is a gasoline-engine-driven generator set capable of furnishing up to 250 watts of power at 115 volts. The units may be either alternating or direct current. The telegraph printer sets are used in the corps teletypewriter net, through which each installation may be switched to any other station within the theater of operations.

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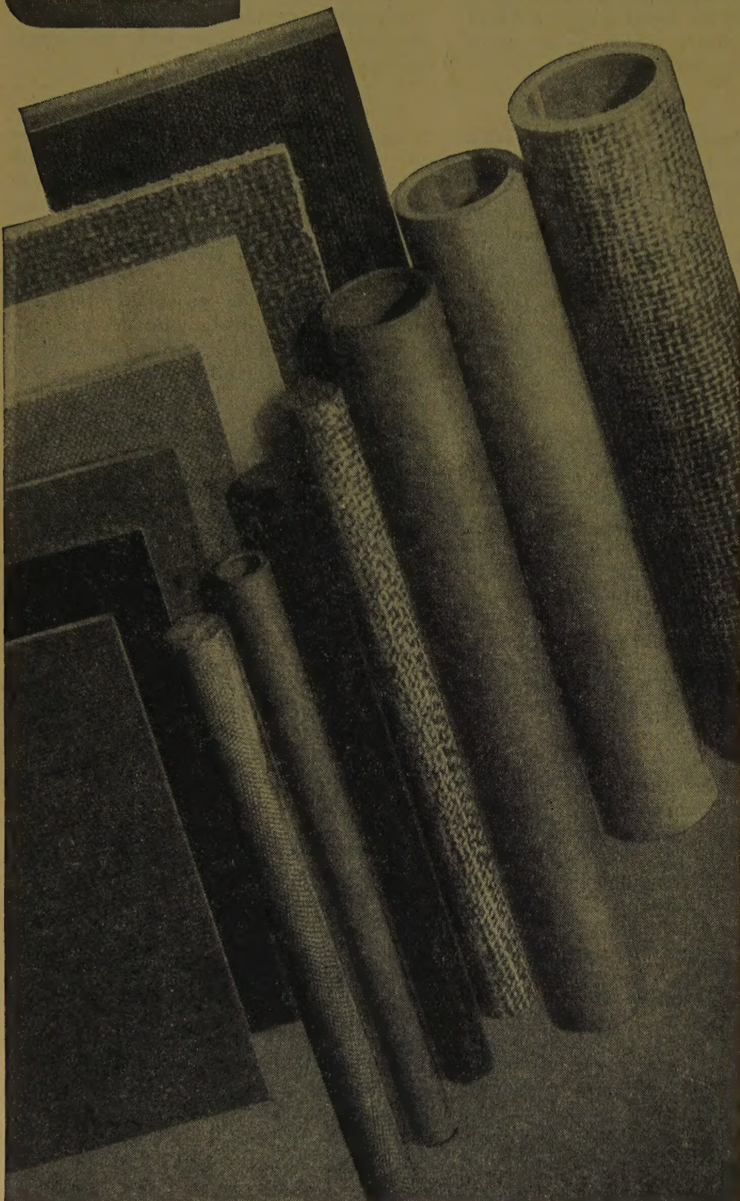

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Infantry Combat Communications

RALPH E. WILLEY
ASSOCIATE AIEE

Signal Corps photo

Communication equipment of varied kinds and in seemingly great quantities is provided for an infantry division in the United States Army. Each item is designed with characteristics to fit it for a particular function in the over-all communication pattern. Nevertheless, as the 104th Infantry Division battled its way through Europe, many problems arose that required improvised solutions to adapt standard equipment to the needs of the moment.

EFFICIENT exercise of command and prompt transmission of information and instructions require the establishment of reliable means of signal communication. This statement from an Army field manual is the basis for the establishment of all communications in military operations. It is the purpose of this article to discuss in a nontechnical manner the communications within an infantry division and some of the problems encountered, together with their solution during combat in the European Theater of Operations. This will include the communications from the front line rifle companies back to division headquarters. Communications of higher headquarters will not be covered.

Communications within an infantry division must provide for 14,037 officers and men. The means used to accomplish this are mainly wire, radio, messenger, visual, and sound. These various means of signal communication are employed so that they supplement each other. The means used as the primary means depend upon the tactical situation and the deployment of troops. However, wire communication constitutes the basic technical means of signal communications for the infantry division. It includes telephone, telegraph, telegraph printer, and any other transmission using wire facilities.

For those not familiar with military organization, a brief review may be desirable. Individuals are organized into squads, squads into platoons, platoons into companies, and so on through battalions, regiments, divisions, corps, and armies. Normally direct com-

Ralph E. Willey, who as a lieutenant-colonel in the Signal Corps served with the 104th Infantry Division, is transmission and protection engineer, Northwestern Bell Telephone Company, Minneapolis, Minn.

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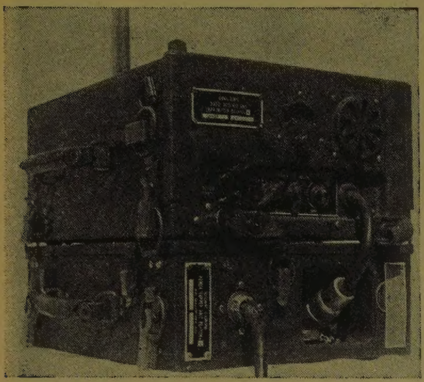

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per minute, a range of 50 miles can be expected where only terminal sets are used.

The wire used in the infantry division is of two types, known as field wire and combat wire. The field wire is a flexible conductor of high tensile strength, composed of a combination of steel and copper strands covered by insulation made of rubber compound and weatherproof braid. The most common type of conductor used is composed of four steel and three copper strands, with a transmission range of from 11 to 17 miles.

Combat wire is composed of one copper and six steel strands, and has a transmission range of from six to ten miles. The weatherproof braid is omitted on this type of wire.

COMMUNICATION PROBLEMS

The outstanding problem for communication personnel in an infantry division is in providing continuous communication to all elements of the division at all times. Communication is necessary at all times for a commander of a unit, no matter how small or how large a unit, in order that he may control the movement and action of his unit. Once communication is lost, control is lost, which may result in the difference between success or defeat. In rapidly moving situations and under heavy battle conditions, this problem is solved by the untiring efforts of all communication personnel and an inexhaustible supply of equipment and personnel replacements.

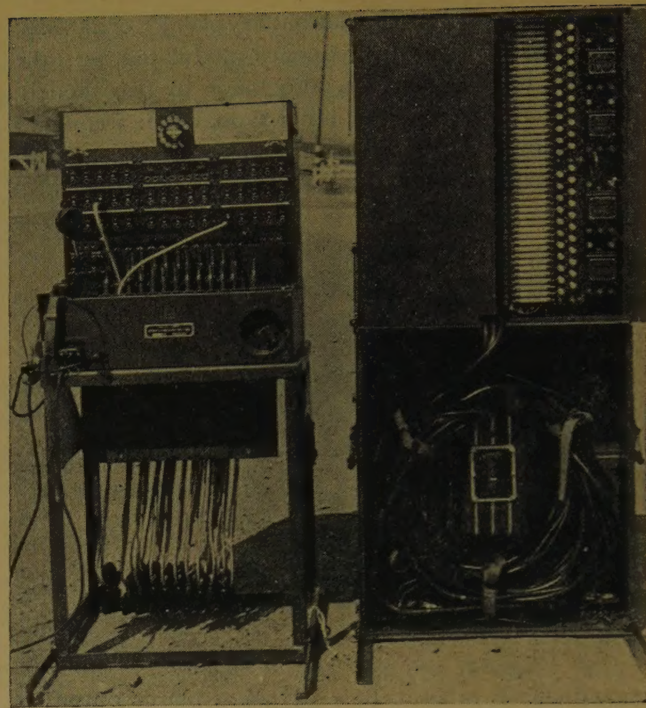

Figure 4. Telephone central office set TC-4

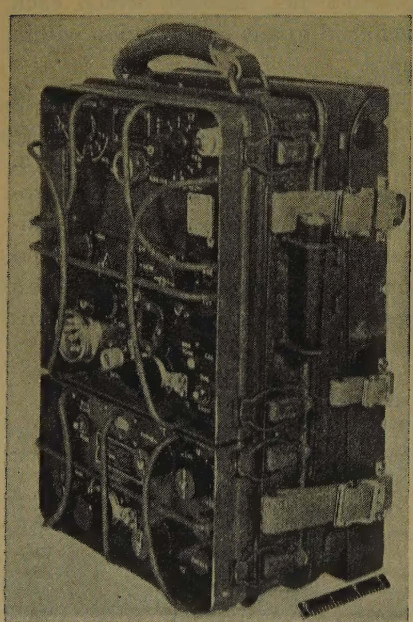

Figure 3. Radio set SCR-694

A protective grille prevents accidental contact with the controls when the set is in a moving vehicle

Signal Corps photo

Isolated problems involve traffic control, particularly in the early stages of a river crossing, "sleeper" patrols into enemy lines lasting for indefinite periods, forward observers for artillery and mortar fire control, and communication between foot troops and attached tank units. Other problems which are more or less technical include field expediencies for overcoming transmission difficulties on long connections involving built-up circuits; provision of means for bridging breaks in field wire, and natural obstacles such as rivers and lakes; remote control of radio sets in the front lines; and other problems presented by the tactical situation.

Continuous communication is maintained by advance planning, keeping abreast of the situation, and supplementing communication means and facilities. Lateral communications are provided between all units throughout the theater of operations. This provides a large number of alternate routes to each unit. Wire networks are extensive, particularly in defensive operations. At the crossing of the Roer River, one division, with attached troops, had over 3,000 miles of field wire in use previous to the crossing. The area covered by the units of this force was approximately 20 square miles. Wire always is laid forward as rapidly as possible and as far as the fighting will permit. As each echelon moves forward, maximum use is made of wire released by the other unit. No command post of any unit is opened at its new location until communication is established at the new location.

In the rapid advances made between the Rhine River and the meeting of the Russians, wire communication between the lower units and from division to lower units was dropped during the day and voice radio used. The units were connected by wire at night for use in planning operations for the following day. The units were spread out over great distances during part of this operation and even with the higher powered radios, it

was necessary to provide relay stations. At one time, the 104th Infantry (Timberwolf) Division, of which the author was a member, was extended over 75 miles. Wire communication was maintained, however, in this situation, by using existing open-wire lines and using two switching centrals.

In the crossing of the Roer River in front of Duren, Germany, one of the most extensive traffic control problems was presented. Three bridges were to be constructed initially as soon as a bridgehead was established by the infantry. Detailed plans and timing of elements to cross each bridge were made, but due to unforeseen activities of enemy shelling and bombing of bridge locations, it appeared advisable to provide a special communication arrangement for the military police at these locations. The distances from the crossing sites to the traffic control points were such that the SCR-300 radio set, previously described, was suitable and a radio net was established with these sets located at points selected by the provost marshal. A wire net also was established but, because of enemy shell fire, continuous operation of this means could not be maintained. This radio net proved extremely valuable in directing and diverting traffic over the various bridges during the crossing and greatly aided the success of the operation.

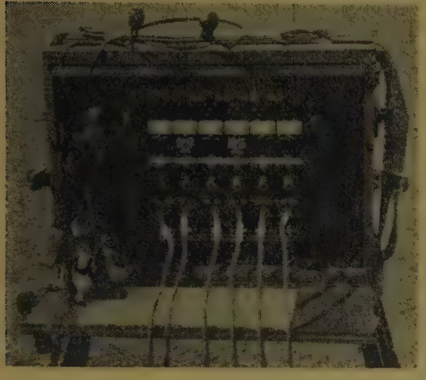

Figure 5. Switchboard BD-71

Previous to the crossing of the Roer River by the Timberwolves, a large number of patrols had crossed the river and secured valuable information of front-line enemy troops and installations. Communications with patrols of this type was maintained by using the sound-powered telephone, small "walkie-talkie" radio, or visual signals such as pyrotechnics. However, before making the crossing, it appeared desirable to secure information of installations in the enemy rear areas. This required that a small patrol penetrate deep into enemy territory and remain there at least 24 hours to observe enemy movements during the daylight hours.

USE OF PIGEONS

With the distance and terrain involved, the small radios which could be carried by hand could not be depended upon. To provide communications for this patrol, two homing pigeons were carried by the three-man patrol deep into enemy territory. One pigeon was released in the morning after their arrival at night and the other released before dark of the same day so as to assure that the information gathered would be returned in case of failure of the patrol to return successfully through the enemy lines. The release of the pigeons during daylight hours was necessary as pigeons must be trained for night flying, and no such pigeons were available for this operation.

The pigeon loft where the pigeons were obtained was located at army headquarters, about 75 miles from division headquarters. The messages delivered there by the pigeons were sent by teletypewriter to division headquarters, where the information was evaluated.

Figure 6. Switchboard BD-72

Normally, the forward observers for artillery units use the two-channel frequency-modulated radio previously described. In some situations, this set is too bulky to carry as far forward as is necessary to observe properly and adjust fire to support the infantry troops. The SCR-300 was used to relay messages from the forward position to a suitable location for the larger set, which is normally in the fire control net. In other situations, the sound-powered telephone was used from the observer to the radio set location.

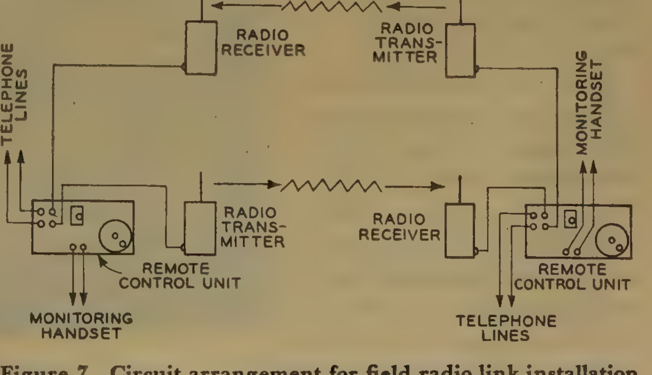

Figure 7. Circuit arrangement for field radio link installation

Communication between foot troops and attached tanks was solved by equipping the tanks, in addition to their normal radio equipment, with an SCR-300, and operating them in the same net with the infantry troops to which they were attached. Communication is often necessary between foot troops from the exterior of the tank and the occupants of the tank when the tank is "buttoned up" with no communication to the outside except radio. This was provided by installing a telephone handset at a suitable location on the exterior of the tank and connecting it into the circuit of the interphone system of the tank.

Table III. Average Monthly Replacements of Major Items of Signal Equipment

Field wire, miles	1,540	Switchboards	3
Portable radios	90	Telephones	110
Vehicular radios	6	Batteries	39,170

With all installations made with field wire, the transmission between long lines, particularly in the rear areas, becomes difficult. On lines that exceed 12 to 15 miles, a repeater similar to the commercial 21-type repeater is available. This repeater, however, can be used only as an intermediate repeater, and where circuits of insufficient length to use the repeater are built up through several switchboards, some means of voice amplification is necessary. This was accomplished by modifying the regular repeater for terminal use and connecting it into the regular magneto telephone circuit so that the repeater was placed in the transmitter circuit when the butterfly switch on the telephone handset was pressed to the "talk" position, and it was in the receiver circuit when the butterfly switch was in the "receive" position. This arrangement could be switched in and out of the circuit as required. This modified repeater was installed on those telephones requiring it.

One of the outstanding facilities for providing uninterrupted telephone communication from division headquarters to corps headquarters is radio link equipment. This equipment is not authorized for an infantry division but usually is furnished, installed, and operated at division headquarters by higher echelon signal units for safeguarding continuous telephone communication to corps and higher headquarters. This installation involves a radio circuit between the two headquarters, connected directly into the headquarters switchboard, thus providing a radio circuit directly under the control of the telephone switchboard operator. It proved so successful in such installations that a small radio link circuit for lower units was developed in the field using standard authorized equipment of an infantry division and providing a radiotelephone circuit connected to the unit switchboard for safeguarding voice circuits or in bridging terrain over which it was impossible to lay field wire. This circuit arrangement is shown in Figure 7 and was used between division and lower units and between regiments and battalions.

REMOTE CONTROL

To obtain satisfactory radio transmission, it is necessary to locate the radio in such a place as to take full advantage of both terrain and structures. This location usually exposes the operator to either small arms or artillery fire and often to both. To provide for suitable radio location and protection for the operator, field-expedient remote controls were developed. However, practically all radios, including the voice-operated SCR-300, were remotely controlled. The control unit provided for complete control and operation of the set from a distant point. This permitted the operator to have the protection of basements of nearby buildings, fox holes, or other places of safety. Many lives were saved by this arrangement.

Due to the proximity of adjacent units, the many

Signal Corps photo

Figure 8. Repair of nonoperative equipment augments supply

attached units, and the large number of radios operated by each unit, careful selection and assignment of radio frequencies was necessary to prevent interference of operating sets. Local interference and vagaries of radio transmission are problems that arise daily and must be solved by normal field expedients.

Satisfactory operation of all the vehicular frequency-modulated radio sets was obtained only by using the correct number of antenna mast sections and accurate lengths of lead-in wire. Both of these items are critical in obtaining desired distances with these sets. Considerable increase in the range of these sets was obtained by constructing, in the field, half-rhombic antennas where

Signal Corps photo

Figure 9. Signal men of the United States Ninth Army testing communication wires in a town in Germany

conditions for visual security from the enemy would permit. The half-rhombic antennas also provided a highly directional beam with a width of approximately 40 degrees.

The laying of field wire across rivers, gulleys, and other natural hazards often presented a problem. Methods of bridging these were developed by fastening the wire to a "bazooka" rocket or a rifle grenade and firing it across the obstacle. This method proved to be one of the most expeditious ways during combat.

Communication by vehicular messengers proved no particular problem with the exception of the necessary protection. Night messengers never were sent out unless absolutely necessary and messengers always traveled in pairs, never alone. However, even with these precautions, several messengers were captured during the drive into enemy territory during the last phase of the Battle of Central Europe.

Use was made of visual signals such as pyrotechnics and smoke for marking front lines, marking targets for air bombing, and controlling artillery barrages.

SIGNAL SECURITY

One of the most important elements of all military communication is secrecy or signal security. This is obtained by various methods. One of the first is the selection of the means of transmission. In general, those means which are most secure are required to operate to their full capacity before a less secure means is employed, even though all less secure means available are kept in readiness for employment as needed. When security becomes the paramount consideration in any operation, the use of insecure means is limited for the periods and to the extent demanded. Radio communication may be prohibited entirely and the use of other means may be authorized only in urgent cases.

Additional security is obtained by the maximum use of codes and ciphers, and by the assignment of radio frequencies and call signs. Cipher keys for cryptographic devices are changed as often as experience indicates the necessity. This is usually daily.

SUPPLY

As previously stated, the maintenance of adequate communications under combat conditions requires an inexhaustible supply of equipment. The average battle losses and requirements per month for some of the major items of equipment in an infantry division is shown in Table III. These figures are compiled from the requirements of the Timberwolf Division during six months of combat. This period involved approximately three months of defensive and three months of offensive combat.

It will be noted that the supply of batteries was one of the major items. Of the average figure of 39,170, 31,100 of these were the flashlight battery type, which as indicated previously was used in the magneto telephones and switchboards in addition to the flashlights. The greatest consumption of batteries for any one month during the 6-month period was 70,968, of which 54,400 were of the flashlight type.

In addition to the replacements required, an average of 110 radio sets and 210 items of telephone equipment were repaired and returned to the units for reuse each month.

It is through the constant planning of communication officers, the untiring efforts of all communication personnel, and the adoption of the agencies of signal means to the situation that continuous, reliable communication is made available to all commanders of a combat unit.

Impact of the War on Science

LYMAN J. BRIGGS

WE HAVE HEARD a good deal during the past months about the importance of science in the war effort. I shall ask you now to turn the phrase about and to consider with me the impact of war on science.

I have seen the United States engaged in three wars. Shortly after war with Spain was declared in 1898 I visited an Army training camp in Virginia, just a few miles from Washington D. C. The place was swarming with flies. The sanitary provisions consisted of open latrines. During the years 1898 and 1899 more than half of the United States Army was incapacitated with typhoid, typhus, and intestinal diseases. Deaths from disease outnumbered deaths on the battlefield nearly four to one.

The retiring director of the National Bureau of Standards here reverses the trend of recent public statements and considers the impact of war on science, including resultant implications and obligations for research in the interests of keeping the peace.

This shocking state of affairs aroused the country and led to much-needed support for the Army Medical Corps, with amazing results. Yellow fever practically was abolished from America. The incidence of malaria in the Army fell from over 700 per 1,000 in 1901 to 8 per 1,000 in 1927. The death rate from typhoid, typhus, and intestinal diseases dropped from 1 in 100 in the Spanish American War to 1 in 10,000 in World War I.

In World War II, when Japan invaded the East Indies, the United States' supply of quinine was cut off but fortunately atabrine came to the rescue. New sulfa drugs were developed for the first-aid kits of the fighting men. The outstanding bactericidal effects of penicillin were recognized and its production and purification were undertaken on an astounding scale. Men discovered how to prepare blood plasma so that it would keep almost indefinitely. With the aid of sulfa, penicillin, and blood plasma and the help of those unarmed heroes of the front line, the Medical Corpsmen, the Army Medical Service was able to save the lives of 96 out of every 100 wounded men.

These precious achievements of medical science would have come to us eventually in times of peace, but the impact of the war accelerated their development tremendously and they are now available to every physician.

EFFECT OF DDT

Mention should be made also of the remarkable chemical called DDT. Its insecticidal properties were discovered in Switzerland in 1940 and in 1942 its production was undertaken both in the United States and in England. Germany and Japan apparently never acquired possession of it. So potent is this chemical that a light spray application on the walls of a house will kill flies and mosquitoes lighting on the wall for weeks afterward.

In World War I, body lice were destroyed by the soaping and bathing of the men and by baking their clothing but the soldiers' clothing soon became infected again in the trenches. Louse-borne trench fever was prevalent. In World War II this problem was solved by DDT. Treating the clothing with a suitable emulsion of DDT kills the lice crawling on it for weeks afterward. This treatment was highly successful in preventing infestation in the American and British forces in striking contrast to conditions among the Nazi troops.

The systematic application of DDT powder to the clothing of every inhabitant of Naples checked what promised to be a virulent typhus epidemic. In the South Pacific campaign, the medical treatment of malaria and the preventive measures, including DDT, were so effective that malaria became an effective ally. Preventive measures were almost nonexistent among the Japanese.

DDT thus represents another contribution of science to mankind which was accelerated by the war. Its value in field and garden, where friendly and pollinating insects must be protected, remains to be determined. In the home, however, there are no friendly insects.

Enthusiastic exponents of basic research have stated that in the course of the war we developed no new basic principles; we only utilized what already was known. This is a matter of definition and I shall not dwell upon it but to me the men who take the germ of a scientist's discovery and develop it painstakingly into something of great value to mankind likewise are not without honor. Consider, for example, "loran," an abbreviation of "long range aids to navigation," in which the underlying principle is radio. Two stations, *A* and *B*, along a coast send out radio pulses at the same instant. The outstanding development is in the receiver, which is carried on a ship or airplane. This receiver measures the difference in the time of arrival of the signals from the two stations, measures it to an accuracy of a millionth

Essential substance of an address delivered at the annual luncheon meeting of the American Standards Association, New York, N. Y., December 7, 1945.

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of a second. Assume that the pilot finds this time difference to be ten microseconds. On his chart he selects from a family of hyperbolic curves drawn between the two stations the curve marked ten microseconds. He knows then that he is located somewhere along this curve. He repeats his measurements with signals coming from *B* and a third station *C* which locates him on another curve intersecting the first. His actual position is the point of intersection and he can find it up to 1,000 miles from the stations with a precision comparable to that of the standard methods of navigation. The method is quick and it can be used in fog or at night. More than 80 such stations have been established by the Navy Department, many of them in the Pacific. Their continued operation would be a great boon to safe navigation by sea and air in these areas.

DEVELOPMENT OF RADAR

Radar was one of the early and outstanding contributions of science to the war effort. In this process the transmitted radio pulse is reflected from a distant object to the receiver and the elapsed time provides a measure of the distance of the object while the angular position of the radio beam fixes the direction. When the radio beam is made to sweep the horizon, the shore line and intervening objects are mapped out in correct position on a phosphorescent viewing screen. Radar has been used in countless ways including the bombing of German cities through clouds which hid the position of the attacking planes. It has great peacetime applications in sea and air navigation, particularly in avoiding collisions, as it can be used to measure the height of an airplane above the ground or the distance of an approaching mountain.

The proximity fuse is another outstanding development based on radio. The fuse in the nose of the bomb or rocket or shell is, in fact, a complete radio transmitting and receiving station, so small that in some models it can be covered by a man's hand.. The fuse picks up its own transmitted beam as reflected from the target and as modified by the Doeppler effect. When this reflected signal reaches the required intensity, the fuse explodes the missile.

A missile armed with a proximity fuse which explodes it 30 or 40 feet above the heads of moving troops or men in foxholes has been shown to be from 5 to 20 times as effective as the same missile armed with a contact fuse. Similarly, a proximity fuse will explode if it comes within 50 to 75 feet of a passing airplane. In fact, its effectiveness against airplanes is so great that for months our high command withheld its use, fearing that it might fall into enemy hands and be copied for use against us. The proximity fuse is a military weapon and its peacetime applications are not obvious, but the principles involved in the construction of its sturdy midget radio tubes readily may find broad applications.

The outstanding accomplishments already mentioned, to which many others well might be added, were brought about by great teamwork on the part of highly competent men. But the greatest concerted scientific effort of all time on a single project was, I believe, that associated with the atomic bomb. There was so little exact information to start with. Fission of individual uranium atoms was an established fact. It was known that the energy released was very great and that the fission probably took place in the less abundant isotope, uranium 235. This was about the limit of factual knowledge regarding fission in October 1939. The rest was theory, but theory that proved of inestimable value in guiding the experiments. Was it possible to establish a chain reaction? This was the fundamental question and, although experimental work was started immediately, a self-sustaining chain-reacting pile was not accomplished finally until December 1942. Uranium metal of the highest possible purity was needed in large amounts for a chain-reacting pile but up until 1940 only a few grams of uranium metal ever had been produced. The whole problem of the practical production of pure uranium metal had to be met. Similarly, methods had to be developed for the practical separation of the pure isotope 235 from the mixture, which contains only 0.7 per cent of 235. This also was an unknown field but four methods were developed successfully: gaseous diffusion, thermal diffusion, electromagnetic separation, and centrifugal separation. Three of these methods were used in plant production. On the long hard road between the laboratory models of the scientists and quantity production, the Army took over the command from the Office of Scientific Research and Development, with outstanding co-operation from industrial firms.

However, to me the most original and daring concept of the whole undertaking was the use of a great chain-reacting pile to produce a brand-new man-made element, plutonium, atomic number 94, and to produce it, not in the micrograms of the chemist, but in actual pounds of pure separated usable material. It was daring because, at the time the enormously expensive undertaking was authorized, our physicists were not perfectly sure that plutonium was subject to fission but if it was, it had two great advantages. It would utilize the abundant uranium isotope 238 and, as it was another element and not an isotope, it could be separated from the remaining uranium metal by chemical methods.

Here again many difficulties had to be overcome. In particular, the radioactivity of the pile was so intense that it could not be approached. All operations, including the chemical separation of the plutonium, had to be carried out by remote control. The success of the undertaking is attested by the fact that plutonium was used in one of the atomic bombs dropped on Japan.

Assuredly only war or the fear of war could have brought this vast project to such a speedy conclusion. Under normal peacetime conditions, such an enterprise would have extended over many years with grave doubts

as to its financial support. To this extent time has been gained. It remains now for all of us to use all the wisdom at our command to divert this epochal development to the paths of peace. Used in this way, it bids fair to become a truly great contribution to mankind.

THE COST OF WAR

I have endeavored to point out some of the ways in which the war stimulated scientific research that will prove helpful in our peacetime pursuits. We now must look at the other side of the ledger. The loss of men and of potential scientists cannot be evaluated in terms of dollars. We know that it has been great. As to the material cost of the war, a recent computation has placed it near 1,400 billions of dollars, with China not included. Of this staggering total, more than one fourth was incurred by the United States. Funds for research never have been placed high on the budgets of the Federal and State Governments. Our war indebtedness thus imposes a new handicap.

For the past five years the normal training of young men in colleges and universities has been disrupted. The educational facilities afforded to returning veterans were planned to mitigate this loss as much as possible. Early reports on the utilization of these facilities are encouraging, but heavy losses seem inevitable. The great deficiency of men who have carried their training through to their doctorates will be felt keenly in all research laboratories. It has been estimated that not until 1956 will the number of doctorates granted reach the level that would have been attained if the rising curve of prewar years had continued without interruption by the war. Even then the accumulated deficit of trained men will not have been met.

As in all wars, the ledger is far from balanced. One cannot but reflect sadly on how much could have been accomplished for humanity with but a tithe of what the war has cost.

The war has made the American people more research minded than ever before in history. I think this is associated in part with a realization of the need for continued research in the interest of national security, pending the establishment of world security on a firm and lasting foundation. But more than this, the recent release of information about numerous projects heretofore held secret has brought about suddenly a vivid realization of the tremendous role science played in the war. We sense great possibilities if these research activities are directed along the paths of peace.

How is this basic research to be supported? Under our present laws and social order, we cannot look with assurance, in the future, to the endowment of new agencies for research from large private fortunes. Parenthetically, some of those who have decried the fortunes of Rockefeller, Carnegie, and Mellon have applauded, almost in the same breath, the advances in science and the humanities that these fortunes have helped to make possible. The further endowment of scientific research by individual wealth, priceless for the freedom it entails, cannot be expected to meet postwar requirements.

Bills already have been introduced in Congress by Senators Magnuson, Kilgore, and Fulbright which provide for the support of research from Federal funds. A new measure which incorporates features of these bills is being prepared, but as yet has not been reported on by the committee. The interest shown in these measures is in refreshing contrast to that of 1933 when the appropriated funds of the research agencies of the Government were cut by one half. The Magnuson bill was written primarily around the idea of providing Federal funds to universities. The Kilgore and Fulbright bills provide for the participation of Government agencies also in the enlarged research program. Scientific research by Government agencies, and basic research in particular, has not had much support in the past in Congressional circles. I earnestly hope that the greater interest now being shown in research will provide a place in the sun for the old-line Government research agencies also and that they will have the opportunity to show what they can do with adequate support.

ROLE OF INDUSTRY

This brings us to a most important phase of this whole research matter, namely research by industry. I think that it should be encouraged in every possible way, including tax exemptions or similar indirect subsidies. Practically speaking, I think the over-all income of the Government would be increased rather than reduced by a most liberal policy in this respect.

The first World War gave a tremendous impetus to industrial research. Many manufacturers were impressed with the possibilities of a research laboratory in their organization. Inasmuch as the first World War was known as a chemist's war, they hired chemists to direct their laboratories, without too keen an understanding of the problems involved. These chemists were smart fellows. They accepted the jobs with alacrity and assurance and then hired physicists and engineers to help them.

Great contributions to science already have been made by industrial laboratories in this country, including investigations of a fundamental character. There are Nobel Prize men in industry. The war just ended has brought a new realization of the advances that are possible through research. New laboratories will be established, old ones enlarged. With this should come also an enlargement of the relationships of industrial research men. They should not be limited too closely to the job of finding the solution to immediate industrial problems. They should be encouraged by management to extend their investigations to the underlying problems in their field, to attend scientific meetings, to present in journals the results of their researches. Such a policy will pay dividends.

Quality Control Through Product Testing

P. L. ALGER
FELLOW AIEE

How industry can maintain uniformly high standards of quality in large-scale production through the use of statistical quality-control methods is discussed in this article. These methods employ sample testing for an assigned level of quality so that defects may be anticipated thus avoiding waste and assuring a more uniform and reliable final product.

STATISTICALLY CORRECT methods for measuring or proving every material, every dimension, and every complete product must be used if the desirable result, a uniformly high quality of products, is to be attained in large-scale production. Also, the management of a factory engaged in the mass production of a high-quality product must anticipate every variation or delay in incoming materials, in processing, and in demand; and take immediate corrective steps. Failure to do so means a rapid piling up of defective or unneeded parts at some point in the process, with possibly disastrous effects on costs and output.

This problem of management is very similar to that of steering a large ship. The helmsman must have a clear view in order to see every obstacle looming up ahead. He must have powerful and sensitive controls, so that the ship will respond to his lightest touch. He must be acutely aware of the ship's speed and inertia, so that the ship's response to his actions will come at just the right time.

PRODUCTION LIKE NAVIGATION

Starting up production is like getting the ship out of harbor. Progress is slow, there must be backing and filling, with many changes of course, and a variety of obstacles must be circumvented. The ship's pilot meets this situation by advance study of harbor charts, by using a scale model of his ship to determine clearances, and by carefully checking wind, weather, and tides. Similarly, management gains experience with production in a small pilot plant before undertaking full-scale operations.

When he gains the open sea, the helmsman still has the problem of maintaining the ship on a steady course. In earlier days he watched the compass needle and moved the rudder whenever he observed a departure from the true setting. When the angle of yaw was just large enough to see, however, the ship already had gained a considerable velocity of swing and, by the time his correction took effect, he was well off the course. The helmsman was forced, therefore, to overcorrect, which caused the ship to oscillate continually on either side of the true course.

This problem has been solved by automatic steering control. The helmsman (human or robot) is guided by an indicator that measures the rate of change of the angle of yaw. As the rate of change of yaw is at a maximum when the ship is exactly on the true course, the indicator anticipates a departure from normal, and the helmsman is enabled to apply the correction at the exact moment it is needed. The indicator may be set ahead or behind, if necessary, to allow for time delays in the control. In a similar way, statistical quality-control methods are solving management's problems in guiding mass production of high quality products.

Formerly, field troubles were kept to a minimum by giving "100 per cent inspection" to the final product to be sure that no single piece fell below the passing limits. Defective pieces at this inspection were reworked and corrections in process were made when the number of defects became serious. Under this plan, there was a long delay between the discovery of spoilage and its correction. In mass production, thousands of defective parts might have accumulated, and a whole plant sometimes has had to close down, before the trouble could be overcome. At best, the delays and costs of spoilage and rework under this system imposed a serious handicap in the competitive race.

Modern quality-control methods anticipate trouble and enable corrective action to be taken in time to avoid waste. This is accomplished by the following steps:

1. Testing a few samples drawn from each stage of production at regular intervals.

2. Inspecting these samples by measuring them (with an indicator gauge wherever possible instead of a go-and-no-go gauge).

3. Taking immediate corrective steps whenever a sample is found to be outside the assigned limits, even though it is still within the final acceptance limits.

4. Holding all pieces made subsequently to each sample check until the inspection report proves that the next sample is still within the assigned limits.

The cardinal feature of this plan is reliance on test of

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a few samples (sometimes with increased severity of these tests) instead of (or in addition to) applying 100 per cent inspection at a minimum test level. This plan opens entirely new avenues of progress.

A much more expensive and, therefore, more searching test procedure can be used on a few samples than possibly could be used on every unit. The tests may be severe enough to cause damage, or may be repeated until failure occurs, as in life tests. Many qualities of a product, such as resistance to wear, corrosion, or stress, thus can be measured while they would have been missed entirely in 100 per cent inspection.

CONTROL OF WEARING QUALITY

The wearing quality that is all important in determining the value of such consumer goods as shoes, clothing, rugs, paints, tires, incandescent lamps, switches, and electric appliances can be measured regularly and controlled in this way.

To accomplish this, however, a large number of technical problems must be solved, including the following:

1. A test code must be worked out which carefully prescribes the methods of test so that variations in the results obtained will be truly representative of the product. Statistical theory must be brought in to define the variations due to the test methods alone and separate these from the product variations before recording the test results as a basis for corrective action.

2. The number of samples to be tested and the method of their selection must be chosen so that they will be truly representative of the product. With the aid of statistical-sampling theory, the program can be set up to give the results desired to any given degree of assurance. Naturally, the number of samples will increase when the quality is found to be poor or erratic and will decrease when the level of quality rises and becomes more uniform.

3. The quality levels below which none of the tested samples should fall must be arrived at by statistical methods to insure a consistent product. This quality level must compare favorably with the performance guarantees and service requirements. Again, the level of quality specified in test should be proportionately higher, the fewer the number of samples tested and the more erratic the quality.

4. A method of continuously recording and comparing the test results should be established so that changes in the product can be noted immediately as they occur and their causes can be traced with the least delay. This requires that control stations be set up at each of the critical points in the production process and charts be maintained in such form that test results can be correlated readily with variations in process controls.

STATISTICAL QUALITY CONTROL

Taken together, the foregoing procedures constitute the art of statistical quality control. This process deals with variations and margins above assigned goals. It is thus as well adapted to reducing costs or speeding production of products so that all meet the quality requirements as it is to improving the quality of products that are technically unsatisfactory.

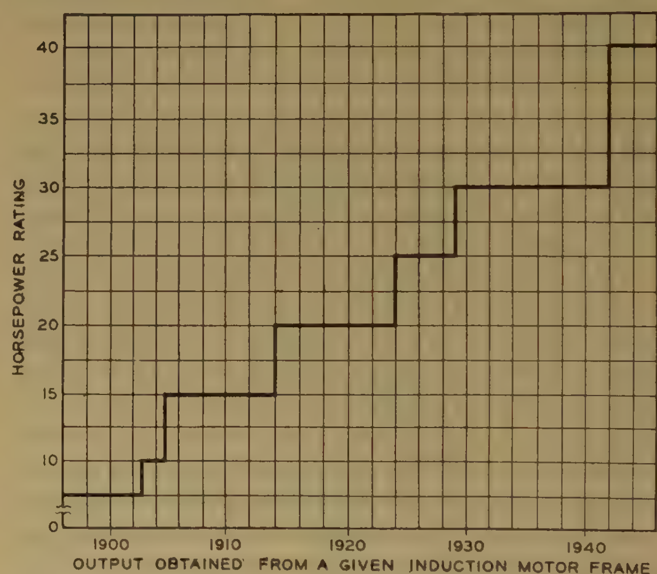
By this process of statistical quality control, it will be possible to establish postwar standards for consumer goods that will go far toward satisfying the expressed determination of many consumer groups to require "facts on the performance of things they buy."

POSTWAR PRODUCTION

Manufacturers, with confidence built up by their war experience in high production of technical products for the armed services, are placing a great deal of reliance on these statistical methods in planning large-scale production of consumer goods. Of course, in planning this postwar production, each manufacturer will select the particular degrees and types of quality to feature in his own products. The quality-control test procedure will be set up to demonstrate that the qualities claimed are real and are maintained. On no account should consumer goods standards specify or limit the qualities the manufacturer decides upon, beyond the minimum requirements for health and safety established by industry and government codes.

The new statistical methods allow greater freedom and diversity of products through the means they provide for proving the reliability of each device.

Increase in Motor Output



Motor manufacturers have been active participants in AIEE activities which are concerned primarily with engineering advancement in the electrical industry. The AIEE Standards for motors and generators are published as American Standards. Since 1900 standardization of electric motors has progressed steadily. It has been effected by co-operation between the manufacturer and his customers, by the standardization of manufacturing processes and materials themselves, or through the efforts of various interested groups. This chart illustrates the increase in output from a motor frame of one size as a result of improved design and manufacture and of standardization. During the same period the price declined from nearly $150 to less than $40

Plant Training in a Public Utility

HARRY C. WALKER

Variations in training methods employed in a shop and in a service organization are contrasted. Steps in a craft training course with easy-to-learn jobs taught first, and others according to their difficulty both of learning and performing, are outlined. Special mention is made of engineering training courses and the job instruction involved in the engineering of various kinds of telephone plant.

HISTORICALLY, plant training in the telephone business is as old as the telephone itself. However, in its development of the past ten years, much has been done to apply exact and time-saving training methods which have resulted in better production, higher quality, and safer performance at a lower cost. This is the objective of a plant training program in any type of public utility. Some of the products of a good training program are:

1. The development of improved methods.
2. The introduction of new tools.
3. The use of new and less costly materials.
4. Improved human relations.
5. Improved supervision.
6. An over-all improvement in performance.

Strange as it may seem, training in most industries for many years has been considered a secondary function of management and only until recently has it been used by management as a tool for doing many things successfully which management has tried unsuccessfully to do by other means over a long period of years. Now the field of training is utile in resource and offers unlimited possibilities in the realm of business and industry.

The fundamental principles governing the transmission of knowledge and skill from the teacher to the learner in industry are the same fundamental principles which have existed through the centuries even before the time when Comenius said "We learn by doing." It is in the application of these principles that various types of training efforts differ from each other.

Shop Versus Service Organizations. Most of the books which have been written about training in industry are applied to shop practices and are designed to meet the needs of those groups in industry who manufacture some kind of product. Very little has been written about the application of training to those groups who have nothing to sell except service.

The training problem in a public service organization is different in many respects from the problem presented by a shop organization.

Under shop-working conditions, the people are located in a relatively small area where the supervisor can give his entire attention to the group and help the individual craftsman with his problems almost immediately upon request. In the public utility, craftsmen are spread over a wide area, making it impossible for the supervisor to give immediate and exact supervision. Here much confidence must be placed in the craftsman and in his individual judgment and ability.

Also, high specialization and mass production methods have made it possible for the shop craftsman to be trained in a relatively small number of repetitive operations which do not vary to any great extent. Shop training methods cannot be applied generally to public utility work since practically every job in a public utility is individual in nature and presents new problems which are peculiar to that particular job, varying from all others in the application of general principles to the particular task.

Therefore, the applications of training principles in these two general types of industry vary accordingly. In the shop it is possible to make time and motion studies which will save effort, improve safety conditions, reduce costs, and do many other things. In the service organization, job analysis cannot be carried to too fine a point, because, for example, a telephone installer placing a telephone in one location would have to go through a series of motions involving a certain amount of time which would differ completely from those involved in placing a telephone in some other location.

Training Job in a Public Utility. In a public utility there are three large groups of people who must be trained: the engineer, the supervisor, and the craftsman. While the training principles applying to all three groups are fundamentally the same, they, too, differ in their specific applications.

One of the first general principles that may be applied to plant training in a public utility is that the man must be trained in the things which he will do and accordingly must know in order to do a certain job. This policy makes it necessary to divide the information and skills into three classes.

Some information and skills apply directly to the job to which the learner is assigned or will be assigned. Other data are closely related to job performance but do not apply immediately and specifically. A third

Essential substance of an address delivered before the AIEE Louisville Section, February 16, 1945.

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class of information and skill is more or less remotely related to his job performance. For example, in training a station repairman, training in the types of equipment which he must repair, in methods of fault location, and in working directly with the test center are required information and skills. Also, some knowledge of d-c theory and of some of the simpler mathematical processes is necessary for background purposes. On the other hand, the more complex electrical theories involved in a-c transmission or in the design of station equipment would not be included in his training insofar as this particular job is concerned. Ordinarily, training courses contain required and related information but do not include the more remotely related data. This principle naturally leads to another principle. Training must be job-centered as applied to the jobs of the craftsman, the supervisor, and the engineer.

CRAFT TRAINING

The highly specialized nature of craft work and the constant changing of methods, tools, and materials necessitate definite training processes applied directly to the work done by the craftsman. The consistent progress of public utilities requires that training methods and content of the courses keep apace of the industry not only because of the induction of new employees into the business and the transfer of older employees within the business but also because employees away from the job for leave of absence, sickness, and other causes not only may lose their skill and forget some of the things they knew intimately, but also and mainly because new equipments have been added and new methods developed.

Any successful public utility must continue to provide the type of service demanded by its public and desired by the utility itself. This requires a well-trained plant organization. The craft training problem, then, is to advance all craft employees in knowledge and skill so as to make them most effective in the performance of their assigned duties. The large variety of work assignments in a plant department makes the training problem varied and complex. Instructors, for example, should be trained not only in the general applications but also should be highly skilled in their particular craft, and they, themselves, should constantly be refreshed in the advancement of the craft which they teach. The importance of craft training cannot be minimized, since it is the foundation upon which all plant work rests. It should, to meet the needs of the business, bring each individual to do a safe satisfactory job in the shortest time and at the lowest cost.

One of the definite responsibilities in a craft training program is the selection and training of the instructors themselves. Instructors are selected from the first level of supervision to do classroom or off-job training, a minimum of one supervisor per craft per district. The other supervisors in the districts are trained to do on-job training. Training supervisors devote their time to scheduling, training new instructors, coaching and supervising older instructors, and to the summarization and analysis of training reports and records.

The general plant training organization handles matters of administration, research, the development of new methods, and the publication of training courses and related information. All three of these groups, however, may become definitely interested in and related to special assignments when such assignments involve new methods, new materials, new tools, or the introduction of new courses.

Teaching Process. Much has been done to find the best method for teaching craft subjects. There are many methods being used today and many more which have been tried and discarded. After some 20 years of experimenting the Bell System has adopted what is known as the four-step method.

A plant craft training course is essentially a list of all the jobs in a particular craft or a certain part of a craft. Some utilities list the specifications or practices covering the work operations to be performed in a particular craft, arranged in some arbitrary order. However, the training course must be arranged in the learning order. The easy-to-learn jobs are taught first and the more difficult ones are placed in the course according to their difficulty both of learning and of performing.

The arrangement of lessons within the course is based upon five learner requirement factors. They are:

1. Knowledge.
2. Speed.
3. Skill.
4. Accuracy.
5. Judgment.

By taking these factors into consideration, a man will not be called upon for more skill than he has acquired, for judgment which can come only with experience, for more knowledge than he possesses, or for more speed and accuracy than he has attained.

The Craft Instructor. The selection of an instructor for craft training work is perhaps the most important phase in this field of training, since through him is transmitted not only the acquisition of knowledge and skill but also the interpretation of data and the development of attitudes. The qualities to be sought in an instructor fall naturally into three groups: technical, teaching, and personal qualifications.

In addition to his job knowledge which is the primary requisite, a well-trained instructor should have a knowledge and command of the intentional teaching-learning process. He should have a knowledge and command of the various teaching methods with the ability to choose the particular method or methods which will be most effective in any given situation. He should have an ability to make a thorough lesson planning analysis. He should be able to plan and teach a lesson so that the

learner will be conscious of his progress and interested at all times. He should have the ability to follow a definite course which will advance the learner from one stage to another easily and naturally. Lastly, through experience he should acquire those habits and practices as an instructor which will make him a master of the instruction art, able to work into his regular program a wealth of personal features.

SUPERVISORY TRAINING

Committees of several members under the leadership of a chairman have been used by industry to handle details with all degrees of success and failure. The variation in results of such committees can be laid to faulty planning, untrained leadership and lack of definitely stated or understood purpose. In recent years the training of foremen, supervisors, and executives has used the committee process but has gone a long way in correcting and perfecting this procedure.

This technique is applicable in industry for training foremen in the problems and responsibilities of first, line supervision, discussion of supervisory line or staff problems, determination of information which requires analysis and development, and achievement of common understanding and satisfactory agreements with employees and many other uses.

Conference Leader. The selection and training of conference leaders are most important problems. In selection of leaders, particular attention must be given to background and experience both in vocation and in the leadership of men generally. Also some attention must be directed to the possible future development of the individual since leadership in supervisory training has been a stepping stone in the career of many successful supervisors.

The conference leader must have or must develop necessary qualities, such as,

(*a*). He must be able to speak clearly using a language which is correct yet adapted to the idiom of the group.

(*b*). He must be able to think logically and to analyze, enlisting facts and reaching a sound conclusion.

(*c*). He must be able to think on his feet, under fire, and while talking or developing another problem. He must think ahead of the group and be able to draw its thinking into the channels of his own thoughts.

(*d*). He must make his group like him and depend upon his leadership.

(*e*). He must be able to make men talk but not too much, and think—think about what they say and talk about what they think.

After leaders have been selected, the next step in a program of supervisory training is to train these leaders in the processes of conference leadership. The informational or instruction phase of this training includes first, the application of conference leading to the various phases of business involving the handling of people particularly in groups, and second, the definition and classification of meetings and conferences, and a statement and discussion of the conference leader's function in each type of meeting. Thus, it is developed why certain meetings or conferences are successes and why others are failures. Next, the instructor explains the conference process and shows how it parallels the normal thought process and various teaching-learning processes, breaking the conference process down into its various steps and discussing the basic types of discussions and the methods of discussion operation as applied to these various steps.

The practice sessions involve the actual use of conference material by various members of the group, the other trainees serving as a group of supervisors in an actual conference. Various forms have been devised for the instructor exactly to check the efficiency of the would-be conference leaders and give them the benefits of his experience and the experience of others in developing themselves through actual practice.

Supervisory Conference Courses. After the conference leaders or supervisory training instructors have been selected and trained, it is necessary to furnish them with the material which will compose the content of their training and with other material and data to be distributed to the supervisors through them.

At present, we have conference outlines in more than a dozen general subjects which may be used by the conference leader in the general program for training supervisors. Some of these subjects are:

1. Planned supervision.
2. Planning work and employee assignments.
3. Job supervision.
4. Tools and materials.
5. Records and reports.
6. Improving individual performance.
7. Employee progress.
8. Personnel relations.
9. Training.
10. Customer relations.
11. Health and safety, and several others.

In addition conference leaders have been furnished with visual aids in the form of films—slide films and sound slide films—to assist them in developing these assignments.

It is necessary that the foreman not only be well trained in the fundamentals of supervision and management but also be kept abreast of developments embracing the arts and skills of the crafts which he supervises. Insofar as possible, he should be encouraged to retain as many of these skills as possible.

Based upon these principles, foremen should be trained by job instructors in craft subjects covering the crafts which the foremen supervise at periodic intervals in order to insure their having a knowledge and ability as good as or better than that possessed by the men whom they supervise.

Safety Training for Supervisors. Supervision includes the maintenance of safety in the plant and among the plant forces. Therefore, the supervisor should be given that training which will equip him to carry out this responsibility. The publication and issuance of safety practices, bulletins, posters, and other written material are not sufficient equipment for the supervisor as an aid in meeting his responsibilities insofar as safety is concerned. Lectures and demonstrations by supervisors and meetings of the exhortatory type are also insufficient for this purpose. The foreman and supervisor must be given definite training to equip them with the knowledge and ability perceptively to observe people, things, and conditions in order that accidents may be prevented.

This training has proved of inestimable value in the operation and maintenance of plant and property, in the well-being of the working force, in the resultant reduction in cost, and in an increasing prestige and ability for the foreman and supervisor in his own eyes, and in the eyes of his men.

ENGINEERING TRAINING

From the standpoint of a well-organized formal training program, less has been done in industry for the engineer than has been done for the supervisor and craftsman. Perhaps too much has been presumed as to the background and education of the engineer, with too much dependence upon the technical school and upon other departments in the business to furnish the industry with men who needed but little training. To meet this condition a comprehensive training course for engineers has been put into effect.

The Engineering Instructor. From experience, it has been found that the training of the engineer involves both conference procedures and job instruction processes. Therefore, in the engineering instructor must be combined the qualities both of the job instructor and of the conference leader.

In the selection of instructors those individuals should be chosen, if possible, who possess a technical background involving practical experience in the fields to which the products of their engineering are applied in addition to ability and experience in the field of engineering itself.

Engineering Training Courses. Courses of training have been prepared for the engineering instructor which involve conference outlines and job instruction. These conference outlines are similar to those furnished to conference leaders for training plant supervisors. Some of the conferences include such subjects as:

1. The engineer in industry.
2. Problem solving.
3. Engineering presentation.
4. Bell System backgrounds.
5. Interdepartmental relationships.
6. Customer relations.
7. Relations with other companies.
8. The engineer and conservation.
9. The engineer and safety.
10. Engineering inspection.
11. Engineering training.
12. The engineer and human relations.

For job instruction, training courses have been prepared outlining the job instruction involved in the engineering of various kinds of telephone plant. These training courses are arranged in learning or teaching sequence and involve lessons which are analyzed or broken down in the same manner as those prepared for craftsmen in the plant craft job instruction courses.

Further, a course in English applied to engineering presentation will prove of great value both to the individual engineer and to his professional efforts.

These courses are a part of a general engineering curriculum which is divided into five specific phases:

1. A self-improvement study course involving home study and supplementary reading.
2. On-job training, in which special studies of subjects involving current assignments are made.
3. A short period classroom instruction involving exercises and the assignment of fundamental problems for discussion.
4. Regional classroom instruction.
5. General headquarters classroom instruction.

In addition to the vast well-organized library of engineering and departmental operating practices, certain texts have been prepared specifically for use by engineering instructors. One of these texts covers the principles involved in the analysis and presentation of engineering problems, discussing the application of the normal thought or logical processes to engineering problems, but taking into consideration the factor of emotional bias. In addition this text discusses to some extent those types of composition and exposition which may be applied to the presentation of engineering problems. Supplementing this is a second volume, which is essentially a textbook on English, concentrating on those things which the engineer needs. Lastly, a third text gives the engineer an introduction to the organization and its responsibilities, its services, and its relationships.

GENERAL SUMMARY

Summarizing all that has been said, plant training in a public utility is an effort which is wide in scope and varied in character. In it, change is a most constant factor, involving many things which make training a most interesting and attractive profession. The things which have been outlined so briefly can, we believe, be applied to any service organization, particularly a public utility. The principles upon which this program is based have proved to be sound and applicable to changing conditions as we meet them today. Their application will require a great deal of thought and a great deal of work but they can be used to the profit of any organization and to the benefit of every man trained by that organization.

Air Forces' Needs in Electric Equipment

Air Technical Service Command photo

Electric power now actuates 90 per cent of the accessories in modern aircraft. However, further applications and improved reliability still await future development. Some of the needs of the Army Air Forces, with a few of present applications, are given here.

A CARTOONIST interested in aviation graphically amused himself and his followers by depicting an airplane as various specialists saw it. To the electrical engineer it was an elaborate electric system suspended in space without benefit of tangible support in the form of airfoils. At first such a representation appears amusing. Then the fact presents itself that 90 per cent of the total accessories used in modern aircraft are actuated by electric power. Today's aircraft sound a far cry from the time when the major electric equipment in an airplane was a pocket flashlight. The progress made has been tremendous. A pilot on a 4-engine airplane today faces a panel containing upwards of 50 instruments, 70 per cent of which are electric. Maintenance is concerned with some 70 pages of wiring diagrams tracing the aircraft's electric system. It would seem as though the cartoonist were right. It might appear a saturation point has been reached.

But not long ago two bombers took off and flew under the same conditions while carrying the same load and the same amount of fuel. They completed their bombing runs and returned to base. One landed with plenty of fuel while the other exceeded the margin of safety and came in with its fuel cells practically empty. The pilots were good pilots, but were not engineers and should not be expected to be engineers. Automatic engine control would have removed the personal element entirely; the airplanes would have come in with practically the same amount of fuel, the margin of safety could have been increased while actually less fuel was carried, and greater bomb loads would be employable.

An airplane skidded in to a belly landing because a landing gear mechanism failed to actuate otherwise satisfactory gear. Ten men in a bomber saw a wing drop off and only four of the men lived to tell about it. Subsequent examination revealed that the wing was burned off by electrical fire caused by excessive arcing.

A flight engineer at 20,000 feet who knew there was no parking on a cloud encountered trouble he could not remedy. Why? Because the trouble stemmed from marine design theory: if anything goes wrong, stop the ship and make repairs. An airplane cannot be stopped for repairs in flight. The conclusion is that electrical engineering as applied to aviation is in its infancy.

For some time performance and production were the primary concerns of the Army Air Forces. As a result weight was overemphasized necessarily as a consideration in design and reliability of performance and ease of maintenance were secondary. On one important airplane maintenance was the last factor in consideration at the design board. This attitude has changed sharply. The first factor now is reliability. The equipment must work, it must perform well, it must be automatic if possible. Second, the equipment must be easy to maintain. No bombs are dropped from a grounded airplane; bombs may be dropped on it. Third, the equipment must be as light as possible without in any way sacrificing reliability and ease of maintenance.

The primary factor aviation expects of electrical engineering is reliable control of the airplane. With the automatic pilot much has been accomplished in this field. An airplane can have its flight attitude established at a certain altitude and automatically continue in that attitude with deviations of wind and air pockets compensated for by automatic actuation of flight control surfaces. Yet pilots often caution against trusting the automatic pilot too much. This may be the result of a natural uneasiness which causes distrust of any control that is purely automatic. The answer once again is reliability. If accumulative experience proves that the equipment will function and cannot fail, this uneasiness and partial distrust will vanish. The answer to control-

Essential substance of an address presented before the AIEE Dayton (Ohio) Section, April 28, 1944 by **Lieutenant Colonel G. C. Crom, Jr.**, United States Army Air Forces, chief of the a-c power unit section, engineering division, Air Technical Service Command, Wright Field, Dayton, Ohio.

ling an airplane in a set attitude after altitude is obtained, at any rate, is well along.

In engine control there are many variables still to be controlled. Theoretically there is a perfect power curve determining under what conditions an airplane will gain and maintain a prescribed altitude with the most economical fuel consumption. A pilot on a four-engine airplane has four levers per engine each to control the power plant: the throttle, the mixture, the propeller governor, and the supercharger. Any or all of these in various combinations are needed in flying the airplane and controlling fuel consumption. If the proper combination is found, the airplane will follow the power curve and operate efficiently with minimum consumption of fuel. With changes of speed and altitude, however, the pilot will change the throttle position to increase or decrease revolutions per minute, or he may believe that the mixture is not rich enough and increase it. Propeller pitch is changed to meet varying conditions, and increased manifold pressure may contribute to improved flying.

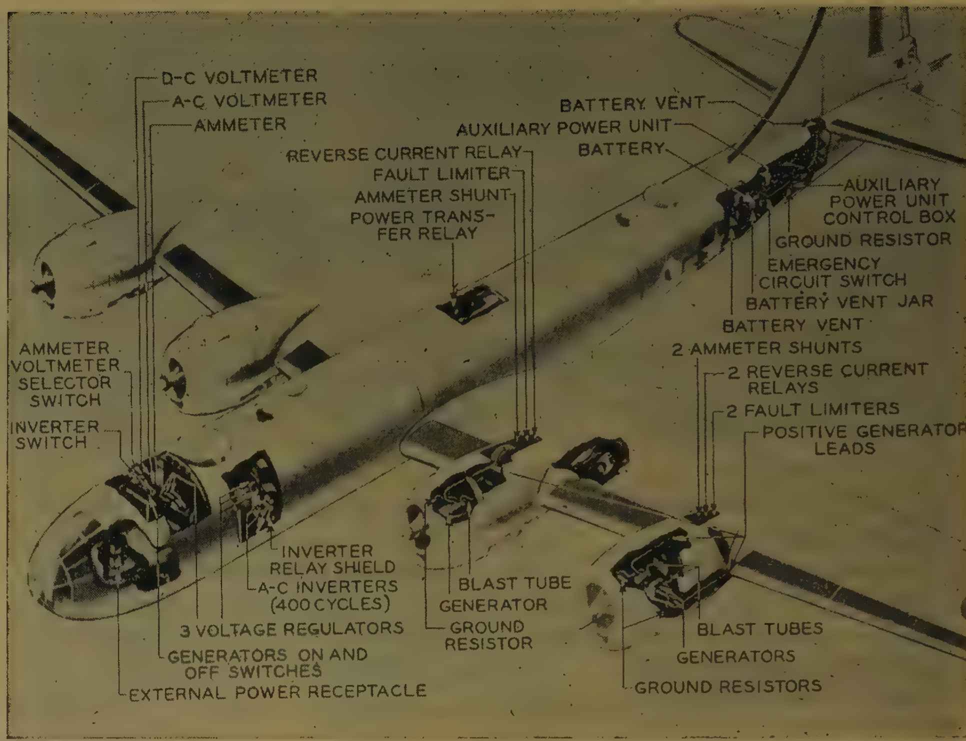


Figure 1. Diagram illustrating extent of power supply system in a B-29 Superfortress

Cameras have been used in aircraft to note how experienced pilots handle their controls. Results show that the pilots constantly are changing these controls seeking a better combination. Often they hit on better combinations. Yet often they merely waste fuel by creating something less than the perfect combination of the four variables. This condition will continue until perfect automatic engine control is arrived at, eliminating the personal factor beyond determining altitude, attitude, and speed to be maintained.

If one lever can be devised for each engine so that speed, mixture, propeller pitch, and supercharger boost will be maintained automatically, automatic engine control will be an accomplished fact. It no longer would be necessary to determine these factors personally in flight. The settings would follow the perfect power curve of maximum performance and minimum fuel consumption. The only personal decision required regarding engine power would be the horsepower desired. Much time and money has been spent in determining where greatest engine economy and efficiency exist. It is difficult for pilots to fly airplanes changing each of the four variables to obtain the proper combinations as set forth in operating instructions. Only automatic engine control will bring this condition into reality.

So far three of the variables governing engine power have been combined experimentally. Speed, propeller position, and manifold pressure can be controlled by one lever. As yet a satisfactory mixture control has not been developed which can be incorporated in the ideal engine control. This advance will decrease the number of levers necessary for controlling engine power on a 4-engine airplane from 16 to 8. Overriding switches are carried, however, because complete reliability has not been attained. Also, so long as mixture control is not automatic, great variations in fuel consumption can exist. So the answer is not complete and will not be complete until one lever will control the throttle, mixture, propeller, and supercharger settings for each engine.

If this is realized, the next step is logical enough. If one lever will control each engine, can the four levers be combined to achieve automatic engine control of a 4-engine airplane by the use of one lever? This lever would follow the power curve for the airplane and maximum efficiency and economy would indeed be achieved. The objection immediately arises that the power required for the four engines is not always the same. This factor can be overcome by devising a lever doing what the four separate levers had done. Such a lever already has been devised experimentally. If this single lever is attained, making engine control automatic, it must be completely reliable.

Continued efficient operation would be aided materially by an efficient detonation indicator. Detonation

is caused generally by excessive manifold pressure or high cylinder temperature. Extremely high localized heat caused by detonation causes pitting and reduces the life of cylinders considerably. The greatest fuel economy can be obtained by operating near the detonation point. Detonation often can occur without being heard, therefore some positive evidence of it should be manifested on the instrument panel. Such a detonation indicator must be simple and serviceable. If the indicator simply could flash to signify detonation it would be excellent. Or one might go further. Efficient operation exists near the detonation point. Exceeding it is dangerous. Could an automatic tie-in be made with a power control lever? Could it be arranged so that the power lever automatically would move back when the detonation point is reached so as to increase the richness of the mixture?

With the automatic pilot and automatic engine control two of the three factors required for automatic flying are solved. The third remains. Can landing be controlled automatically? Take-off can be controlled fairly well at present. Landing is another matter. Locating the runway, learning weather conditions, lowering flaps and landing gear, determining landing speed, and pulling back the stick are a few of the more important factors to consider. Following a beam in has controlled locating the landing strip and eliminated the lost feeling of being in the air in storm or darkness without being able reliably to find a way down and a place to land. The other factors at present largely are unsolved. The pilot puts the airplane on normal controls and brings it in, determining when to lower flaps and landing gear, what speed to employ, and when to pull the stick back. Ingenuity should be able to make these automatic too and with complete reliability. An automatic landing control would take charge of the airplane from the automatic pilot at a certain altitude and speed. Here the importance of a reliable altimeter is realized. The airplane is now following a beam but at this speed and altitude it is also on landing control. Automatically the landing gear and flaps would be lowered and the speed cut. At the proper moment the stick would pull back and a perfect landing would occur.

These control devices should be developed so that by changing cams or by other mechanical means the established pattern can be changed as more desirable factors make themselves evident. Add radar to aid in navigation and to avoid obstacles in the air, and flying seems

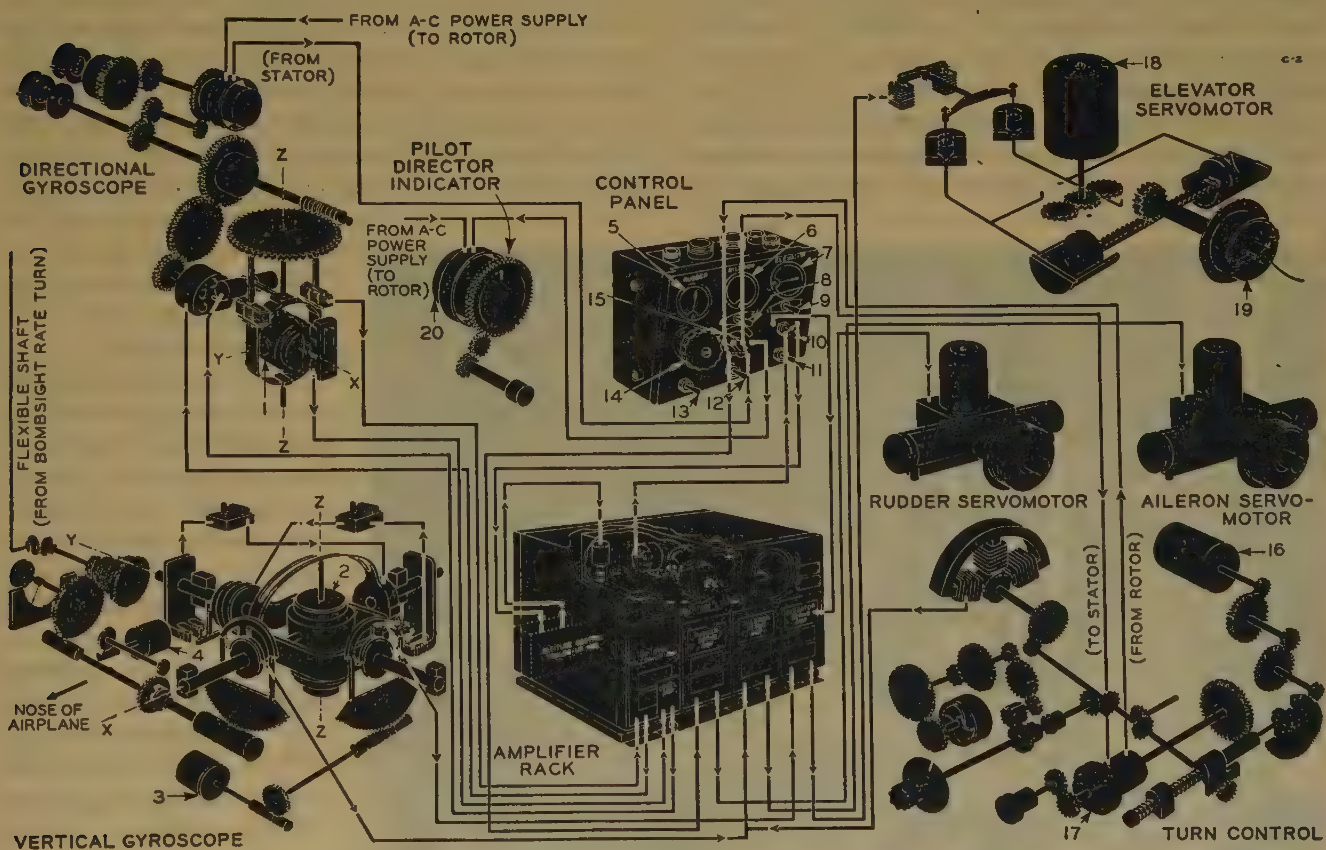


Figure 2. Schematic diagram of automatic pilot in a B-29 Superfortress, illustrating complexity of the system

1—Gyroscope housing
2—Gyroscope
3—Elevator aligning motor
4—Aileron aligning motor
5—Rudder meter
6—Aileron meter
7—Elevator meter
8—Aileron aligning switch
9—Elevator aligning switch
10—Altitude control switch
11—Elevator switch
12—Bombsight switch
13—Rudder switch
14—Master switch
15—Selector switch
16—Synchronous motor
17—Autosyn
18—Pump motor
19—Cable drum
20—Autosyn
X—Longitudinal (roll) axis
Y—Lateral (pitch) axis
Z—Vertical (yaw) axis

absurdly safe. And that is what it will become. Make control automatic, make it reliable, eliminate the personal element so far as possible from things which should be automatic.

As more demand for electric control arises, the need for more power also will arise. At present a d-c system with a maximum of 30 volts is employed. On a B-29 bomber the generating system provides continuous 28-volt direct current to the airplane's electric system. Six 300-ampere 30-volt d-c generators supply power through reverse current relays to the main power distribution circuit. A carbon-pile regulator keeps the voltage of each generator constant within the operating range and under varying local conditions. There is also a 200-ampere generator which supplements the main generating system during take-offs and landings and provides for emergency operation of the electric system. The B-32 is equipped with a 28-volt d-c system, using a grounded negative return through the metallic structure of the airplane. The main power supply consists of two 300-ampere 28-volt generators and two 200-ampere 28-volt generators. There are also a 17-ampere-hour 24-volt storage battery and a 200-ampere 28-volt auxiliary generator, driven by a gasoline engine, which supply power to the fuselage power network. The C-69 has a 28-volt d-c single-wire installation. Power is supplied by two 28-volt d-c generators supplemented by two 24-volt batteries.

To reduce weights of wires needed for these large currents at these low voltages, it is necessary to increase voltages, especially if an increase in electric power is contemplated. Because aircraft operate at altitudes where corona and surface leakage of insulation are increased greatly at high direct voltages, to use these higher direct voltages is not easy. Suitable insulation, spacing, and interrupting devices as well as motors and generators will have to be developed.

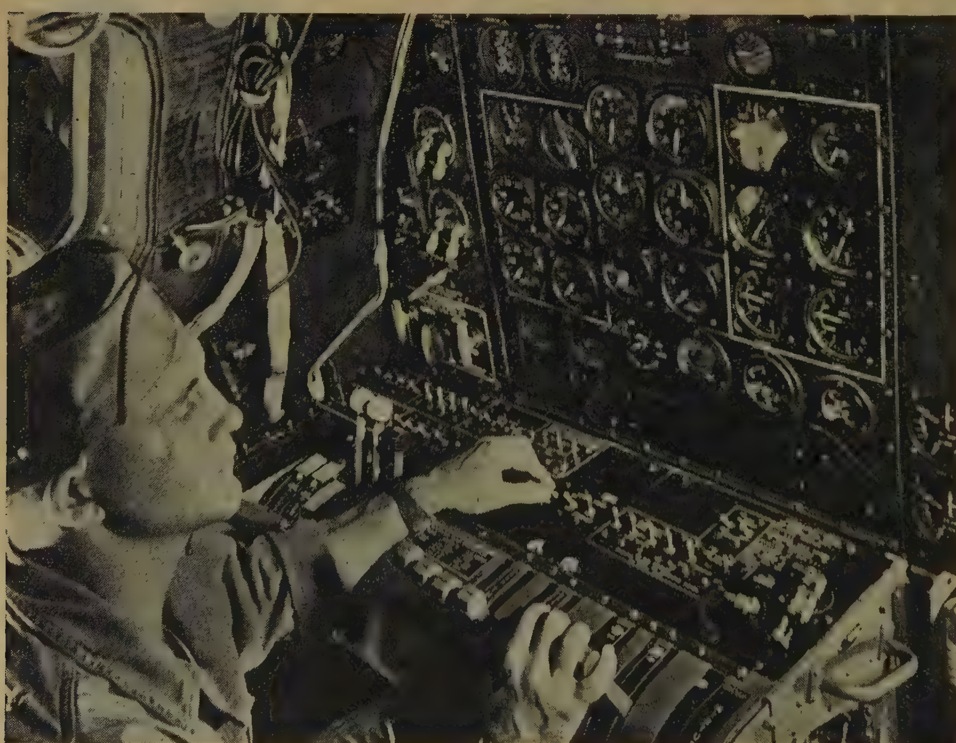
By using alternating current at higher frequencies than is customary for ground operation, some of the difficulties encountered by going to higher voltages are removed and a large decrease in weight is obtained. Alternating current will interrupt easily. Insulation and corona problems are not as severe, and a high degree of reliability is obtained.

Changing from direct current to alternating current would reduce dead weight greatly. For every pound of dead weight it is estimated that it would take two pounds of fuel and oil to carry it 10,000 miles, not an excessive range in view of future considerations. It is conceivable that the use of alternating current rather than direct current might reduce the weight of electric equipment in an airplane one-third to one-half. This would aid materially in supplying greater power without adding weight. It also would make the weight involved more efficient in relation to the power produced.

In the field of a-c research and experimentation for aircraft use, consideration should be given to the development of three-phase motors. New materials may offer possibilities here. Circuit breakers for one to three phases need thought especially as regards reliability. Efficient and reliable turbo alternators are important. Good fuses are also very necessary here, fuses which are easy to get at and replace while the airplane is flying. Fuses also need better indicating devices and complete reliability.

Direct current as it presently is employed stands in need of better circuit breakers and switches. Voltage regulators of lighter weight and greater reliability are required. Circuit breakers which will not fail are of paramount importance. Causes which contribute most to circuit-breaker failure are vibration and altitude. These factors must be overcome to improve the d-c system.

If electric control is to play the important role for which it seems destined, it follows that instruments must improve constantly. They must improve in both relia-



Boeing Aircraft photo

Figure 3. Flight engineer's position in a B-29 Superfortress

bility and simplicity. It is sometimes said without too much exaggeration that a flight engineer in a 4-engine airplane needs to be a graduate electrical engineer. This is really an indication that greater simplicity in instruments is needed. From a standpoint of reliability it is difficult to make a generalization. If all instruments were within two per cent of perfect reliability, however, there probably would be no aircraft failures on this score. It may be that radical changes will produce better instruments. For example, there may be some better method of measuring altitude than the present altimeter.

Boeing Aircraft photo

Figure 4. Radio operator's position in a B-29 Superfortress

The present altimeter admits of many faults prejudicing reliability. Most of these faults cannot be corrected by maintenance at present. Excessive scale error may be noted. This probably is caused by improper calibration adjustment. Excessive pointer oscillation, if present, would indicate defective mechanism. Difficulty in turning the setting knob would be caused by faulty lubrication or a lack of lubrication. The inner reference marker may fail to move when the setting knob is rotated. In this case the mechanism is out of engagement. A cracked or loose cover glass is the result of excessive vibration. Dull or discolored luminous markings may occur as a result of age. Slipping in mating parts will cause the barometric scale and reference markings to be out of synchronism. All of these are faults which affect reliability and yet none of them can be corrected by maintenance. The only solution now is to replace the instrument. Excessive vibration can loosen the setting knob lock screw and actually cause it to come off. If the screw is missing, the instrument must be replaced. Improper venting can cause a high reading. This normally can be corrected by eliminating the leak in the static pressure system and checking the alignment of the air-speed tube. If the altimeter is to play a part in automatic landing control, it is obvious that improvement is necessary and reliability must be stressed.

Vacuum tubes and amplifiers require development. The present vacuum tube is much like an average radio tube. Much better tubes are needed to insure reliability particularly in servomotor operation. Greater sensitivity in amplifiers is needed. A signal must be amplified immediately and sufficiently to operate motors affecting control parts and surfaces. At present there are too many types of amplifiers required. It might be desirable to establish a centralized control for their development in order to obtain standardization. Greater interchangeability could be obtained and the different types of amplifiers required for an airplane might be reduced to three or less. One type of amplifier then would be capable of being used for various components of an airplane. The same type of amplifier, for example, might be used for the supercharger and the approach landing. Maintenance and supply problems thus would be simplified. Extra amplifiers could be carried in an airplane and replacement could take place in the air.

Electric deicing of propellers, and possibly of wings, is another field in which experimentation can provide progress. Airplanes now generally use a deicer system and a propeller anti-icing system. Wings, horizontal stabilizers, and fins are provided with reinforced rubber boots operated by alternate inflation and deflation. The propeller anti-icing system prevents ice formation by distributing isopropyl alcohol along the leading edge of each propeller blade. Electrically powered anti-icer pumps force fluid to the slinger wings on the hub of each propeller. The fluid then is carried along the leading edge of each blade by centrifugal force resulting from propeller rotation. There is reason to believe that propeller anti-icing might be accomplished more efficiently by the use of electric heat. There is no reason why this should not also be true of wings, horizontal stabilizers, and fins. If electric deicing is to be de-

veloped, the first need is for a sure means of detecting the presence of ice. If this can be found, the rest should be relatively simple. Much that is cumbersome, inefficient, and difficult to maintain in deicing today could be eliminated by a reliable electric heat deicing system.

Generally any item of electric equipment must be designed to withstand the effects of vibration and altitude and to give 100 per cent reliability. Airplanes now and, to a greater extent, in the future will be expected to fly at high altitudes for long periods of time. Electrical insulation of present design is beginning to fail as a function of time and altitude. In fact, most electrical failures are initiated by insulation failures. The reasons for these failures are not fully known and have been duplicated only partially under test conditions. It is conceded that some phenomena exist at altitude which are not understood in magnitude and detail. Until these phenomena are known and understood, they cannot be considered in developing a basis for electrical insulation design.

These practically unknown phenomena include the following:

1. The normal increase of ionization breakdown with lowered pressure. This value is believed to be about 4:1.

2. The effects of condensation when climbing to and returning from high altitudes and low temperatures. This effect especially near seacoasts is believed to be the major cause of present insulation failures.

3. The presence of ozone and its generation.

4. The presence of nitric acid and its generation.

5. The effect of ultraviolet radiation on ionization.

6. The extent of photoelectric effects. It has been estimated that photoelectric effects may cause the emission of 0.1 microampere per square centimeter from aluminum and magnesium surfaces exposed to light and altitudes.

7. The effects of fungus. Spores are known to exist at high altitudes and in temperate climates.

8. The effects of cosmic rays on ionization.

If the effects of these physical phenomena were known, electric parts could be designed so that breakdown at altitude could be minimized. The development of better insulating materials resistant to breakdown at altitude also would be of great assistance in solving this problem.

Some evidence has been presented that moisture, high temperature, and surface leakage cause a high percentage of failures in insulation. At high voltages, dielectric flux concentrations may be the cause of some failures. There is fairly general agreement that part of insulation failures result from the high voltage developed when the circuit to electric motors is broken. There is some evidence that an apparent change in the character of an arc resulting from an open switch occurs with altitude up to 25,000 feet. Although this has been objected to, an explanation of this apparent phenomenon would be of value for it might be the unknown force which causes altitude to have detrimental effects on insulation. Electrical failures are caused; they do not happen. If the cause can be determined, it can be removed by proper design.

Terminals and connections should be made waterproof, otherwise insulation failures may be caused by surface contamination caused by the following:

1. Condensation of moisture by alternate heating and cooling.
2. Condensation of salts.
3. Condensation of acids from ozone at altitudes.
4. The presence of dirt, oil, grease, or other contaminants.

Ionization effects which increase with altitude do not affect insulation breakdown directly. However, corona effects may increase with altitude and accelerate surface breakdown by assisting in carbonization of the insulation. The discrepancy of about 20 per cent between breakdown voltages measured in the chamber and in the aircraft at equivalent temperature may be caused by an increased concentration of helium or argon in the upper atmosphere as helium and argon have lower breakdown voltages, 156 volts for helium and 137 volts for argon compared with 327 volts for air.

In summation, failure of insulation in aircraft installations is proportional to time and voltage and is largely a function of surface contamination. Moisture, salts, dirt, acids, and other contaminants are deposited on the surface as the result of alternate cycles of pressure and vacuum, of heating and cooling, and of corona effects which increase with altitude. Waterproofing, when possible, would largely eliminate this cause of failure.

The advent of the gas-fired turbine with its constant speed operation, for best operating efficiency, has set up additional problems, with regard to the operation of aircraft with their variable speed demands, which only electrical design can solve. This is a basic design problem which will require the closest co-operation between electrical engineers, aircraft engineers, and power plant engineers.

The Army Air Forces then look to electrical engineering for improved insulation, for refinements of present electric equipment, and for new and improved installations. Electric power will increase as the functions of electric control increase. To the present features of automatic flight control should be added complete automatic engine control and automatic landing control. The damaging effects of vibration and long flights at high altitude must be eliminated by improved electrical design.

Weight must be kept to a minimum through superior selection of materials and efficient design. Equipment must be designed to enable easy maintenance, a factor becoming increasingly important to aircraft design as a whole. Neither lightness of weight nor ease of maintenance may detract from the main criterion. The first test is reliability. The equipment must work unfailingly.

With these criteria in mind electrical engineering can make a major contribution to the Army Air Forces in maintaining the only position it can afford to strive for, the best air force in the world.

Statistical Methods in Quality Control

VIII. Control Charts for Action on Variables

The use of control charts for action when inspection is by the methods of variables and the factors for control are averages and ranges is discussed herein. The method is illustrated by a typical application; the cutting of small sleeves from a tubing material where weight is one of the critical characteristics to be controlled.

THE VARIOUS uses of the statistical control chart were touched upon in the preceding article of this series on applications to analysis of data. Also of outstanding importance is its use for systematic control supervision of a repetitive operation—a production process or an experimental investigation—where the objective is correction or scientific notation, that is, action, when one or more identifiable factors in a desirably constant complex or system of underlying factors depart from optimum uniformity.

In a production process we want prompt corrective action before poor quality is produced, not screening inspection and scrap afterward. In a scientific investigation we want systematic correction of the experimental methodology or revelation of unknown factors and singularity in the related projection of physical laws. Although the method is applicable to operative problems generally, the illustration here used is a production process.

The checking of every possible contributing factor in each repetition of an operation obviously is impossible. Furthermore, in production it usually is prohibitive to check every part. The statistical control chart method is outstanding for its detection of changes in conditions for prompt correction, that is, for identifying variations not the result of chance. Applied to process checking and product inspection in manufacturing, it provides a basis for reliable and economic action. This article illustrates a typical application.

Consider the cutting of small sleeves from a tubing material where weight is one of the critical characteristics to be controlled. An automatic machine feeds simultaneously a large number of lengths of tubing through guides around a revolving drum against a special cutter. The cut pieces drop into a hopper as the drum revolves. Some of the process factors influencing sleeve weight are variability in diameter and wall thickness of incoming tubing, changes in condition of the cutter, and variations in machine setting. Considerable difficulty had been experienced with subsequent processes because of spotty quality of sleeve weight. Full screening or 100 per cent inspection was economically out of the question.

How can check data be taken economically to allow recognition and correction of changes in process before scrap accumulates?

Following the principle of checking as closely as possible to the potential source of trouble, samples were taken at the sleeve cutting machine. After considering possible frequencies of unforeseen changes in lots of tubing, settings, and so forth, it was decided to take hourly samples or rational subgroups of five sleeves each. It was considered desirable, at least initially, to have control charts for both averages $\bar{X}$ and ranges R of the samples, until stability of the internal variability of subgroups R had been verified.

The next step was the collection of a preliminary or historic sequence to establish tentatively the control chart constants representative of the process. Table I skeletonizes the initial data and preliminary calculations.

The next step was the setting up of control limits, and expectations or central lines, for interpreting future sample results for action in correcting process. The average value of the ranges within samples provides an approximation of chance variability or dispersion, with-

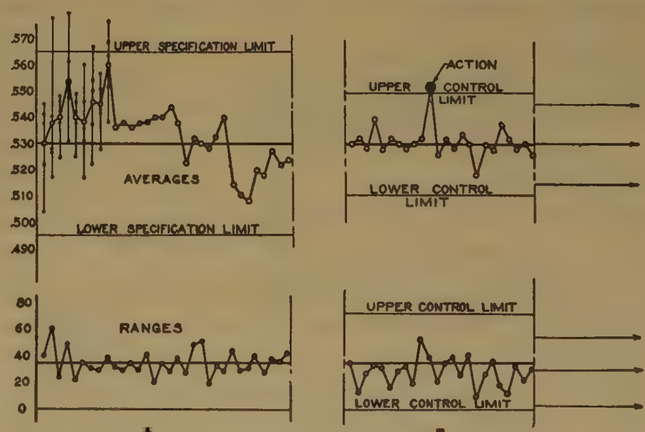


Figure 1. Control charts on sleeve weight

out possible inflation from assignable changes from sample to sample.

The center line standard first must be established for each of the two statistics, average $\bar{X}$ and range R. The grand average of the averages $\bar{X}$ in the historical series often is used for the chart of averages. However, in this

One of a series of articles prepared in the AIEE subcommittee on educational activities and sponsored by the AIEE subcommittee on statistical methods.

Personnel of the AIEE subcommittee on educational activities: J. Manuele, H. G. Dodge, A. I. Peterson, and R. E. Wareham.

Table I. Preliminary Control Samples on Sleeve 912Z

Specification Limits: 495–565 milligrams — *Machine: 41*
Characteristic: Weight — *Sample Size: 5*

Sample Number	Date	Hour	Average	Range
1	1/16	8 a.m.	530	41
2		9	538	61
3		10	540	23
4		11	554	49
5		12 noon	540	21
6		1 p.m.	538	34
7		2	546	30
8		3	544	29
9	1/17	8 a.m.	560	39
10		9	536	31
*		*	*	*
*		*	*	*
*		*	*	*
32	1/19	3 p.m.	524	42
Sum			17,066	1,094
Average			$\overline{\overline{X}} = 533.3$	$\overline{R} = 34.2$

case, we preferred the objective midpoint of the "specification tolerance limits," that is $(495+565)/2$ or $\overline{X} \times 530$ milligrams, because it was desired to converge variations around this level. For the chart of ranges R, the selected standard value of range R_n' was based upon verification that $\overline{R}$ would, under controlled conditions, permit all but a negligible fraction of individual pieces to lie within specification tolerance limits.*

Through the use of the calculation factors in published manuals on control charts* three-sigma or control limits for averages and ranges, based on given sample size, are computed as follows:

For averages

$$\overline{X}' \pm A_2R_n' = 530 \pm (0.577)\ (34.2) \text{ using } \overline{R} \text{ as } R_n'$$
$$= 510.3 \text{ and } 549.7$$

For ranges

$$D_3R_n' \text{ and } D_4R_n' = (0)\ (34.2) \text{ and } (2.114)\ (34.2)$$
$$= 0 \text{ and } 72.3$$

In Figure 1A plots of the averages and ranges in the preliminary period are shown. The chart for averages indicates the specification tolerance limits (for individual values). Also, with the first nine averages are shown the individual measurements for each sample in order to stress the necessity for visualizing the spreads around averages, and to indicate that averages cannot be compared simply against specification limits for an interpretation of significant variations.

These center lines and control limits then were projected for supervision of regular production performance of the process. As each sample was taken, average and range were computed and plotted on the prepared chart. As any new point indicated a change in conditions by appearing outside limits, or by indicating trend, investigation of process was made. It soon was discovered that significant or assignable changes were associated with "maverick" lots of tubing, machine drift, and cutter maintenance. Better procedures for setup, more refined adjustment, and better incoming material inspection soon stabilized performance.

Figure 1B illustrates a later period with the same control chart standards. Note that only one correction was necessary, at the point marked action, where a maverick bundle of tubing got into the supply rack. Also note that now the internal variability was reduced in level (average range $\overline{R}$), warranting the recomputation of control limits for the future period, as indicated by the new lines to the right.

* Discussion of the setting of control chart standards will be found in American Standards Association control chart publications.[1–4]

REFERENCES

1. ASTM Manual on Presentation of Data. The American Society for Testing Materials, Philadelphia, Pa., 1941.

2. Control Chart Method of Controlling Quality During Production. American War Standard ASA-Z1.3, American Standards Association, New York, N. Y., 1942.

3. A First Guide as Quality Control for Engineers. Ministry of Supply, London, England, 1943.

4. Quality Control Chart Techniques When Manufacturing to a Specification. The General Electric Company Ltd. of England, London, 1943.

Antenna of Portable Radar Set

Westinghouse photo

Rotating "beach umbrella" antenna used as a reflector in sending out short-wave radio pulses and as a receiver to "catch" wave echoes reflected by enemy targets. It is part of a portable 400-pound radar unit with an 80-mile range

INSTITUTE ACTIVITIES

A Message From the President

The membership of the Institute is now rapidly approaching 25,000. This is gratifying evidence of success, but if growth leads to inertia and success to complacency, seeming gains may be hidden losses. It is time to look at ourselves with the eye of a friendly critic.

It is becoming impossible for our national officers to know more than a small fraction of our members. An incoming president is confronted with the task of setting up a national committee organization which may include almost a thousand members while his own acquaintance covers only a limited sector. By the time he has really felt the pulse of the whole organization his term of office is over. He finds that he can do little to direct the Institute's activities into new channels beyond the preliminary spade work. Our secretarial staff, busy with their appointed duties at headquarters, can give little time to field contacts. The policy of the Institute has not expected them to assume initiative in shaping its organization and activities to meet changing conditions.

These policies, which guard against hasty and ill-considered change, make for stability at the expense of adaptiveness. As a consequence, the Institute's organization is likely to follow advances in electrical science and art somewhat tardily rather than anticipate them, leaving the door open to special groups to organize separately in new fields of interest. Fortunately, our Sections can act more quickly and there are many excellent examples of special group activities under their sponsorship. How can we make the Institute so representative of newly developing interests and so effective in its service to those who pursue them that no electrical group would be tempted to go outside its fellowship to organize in some area of specialization?

The engineering profession, which with the allied sciences, ought in terms of numbers and of function to be the most influential professional group in America today, actually is one of the most impotent in public affairs. When issues arise, instead of raising one voice, we raise a Babel of 90 voices and the result is too often mutual cancellation. In public matters, some sort of solid front is needed, and the Institute, as the largest of our engineering bodies, not only should assume a full measure of participation, but also should share substantially in leadership. If we attempt a solid front only at the stratosphere level, without its counterpart at the grass roots, it is unlikely to survive. Witness the American Engineering Council.

It is a time for close, realistic, and constructive thinking on these issues. What can engineers do best through special purpose organizations, what through organizations spanning a major sector of interest, and what through Federal or over-all organizations at the national, regional, state, or local level? How far can we go and what immediate steps can we take toward rationalizing the Topsy-like growth of the past and guiding the evolution of the future, and particularly what can we do now, right here in the Institute's domain, to advance these ends?

These questions are the present concern of our committee on planning and co-ordination and of its two special subcommittees of inquiry, one probing into the effectiveness of the Institute's technical committee organization, and the other into its interorganization policies and machinery. To do a job, these committees must hear from our members, our Sections, and our District executive committees. To augment the grist the mail is bringing in, an open forum is being planned as part of the winter convention. It should be one of the most largely attended and lively sessions of the convention. We want to hear from you, and we want to hear it straight.

William E. Wickenden

AIEE Nominating Committee for 1945-6 Announced

The nominating committee of the AIEE, in accordance with the Institute's by-laws, will meet during the winter convention January 21–25, in New York, N. Y., to nominate candidates for national offices to be voted on by the membership in the spring of 1946. Members of the committee are as follows:

Representing the board of directors

C. B. Carpenter, Pacific Telephone and Telegraph Company, Portland, Oreg.
C. M. Laffoon, Westinghouse Electric Corporation, East Pittsburgh, Pa.
F. L. Lawton, Aluminum Company of Canada Ltd., Montreal, Quebec, Canada.
J. R. North, Commonwealth and Southern Corporation, Jackson, Mich.
H. B. Wolf, Duke Power Company, Charlotte, N. C.

Alternates

J. F. Fairman, Consolidated Edison Company of New York, Inc., New York, N. Y.
W. B. Morton, Pennsylvania Power and Light Company, Allentown, Pa.

Representing the ten geographical Districts

1. F. S. Bacon, Jr., Westinghouse Electric Corporation, Boston, Mass.
2. H. A. Dambly, Philadelphia Electric Company, Philadelphia, Pa.
3. J. L. Callahan, Radio Corporation of America, New York, N. Y.
4. J. G. Tarboux, University of Tennessee, Knoxville, Tenn.
5. E. W. Seeger, Cutler-Hammer, Inc., Milwaukee, Wis.
6. L. R. Patterson, Public Service Company of Colorado, Denver, Colo.
7. R. C. Horn, Southwestern Bell Telephone Company, St. Louis, Mo.
8. Ben Ferguson, Headman, Ferguson, Carollo and Classen, Phoenix, Ariz.
9. J. F. Gogins, General Electric Company, Spokane, Wash.
10. A. W. Murdock, Hydro-Electric Power Commission of Ontario, Toronto, Ontario, Canada.

Alternates

L. G. Weiser, Westinghouse Electric Corporation, Louisville, Ky.
L. A. Stenger, Great Western Sugar Company, Denver, Colo.

Philip Sporn Selected for 1945 Edison Medal

Philip Sporn (F '30) executive vice-president and chief engineer, American Gas and Electric Service Corporation, New York, N. Y., has been named the recipient of the Edison Medal, highest AIEE award, for the year 1945 "for his contributions to the art of economical and dependable power generation and transmission."

Mr. Sporn will be presented with the medal on Wednesday, January 23, 1946, at the morning session of the AIEE convention.

A biographical sketch of Mr. Sporn will appear in an early issue of *Electrical Engineering*.

Monday, January 21

9:30 a.m. Protective Devices I

46-19. Field Tests of Interrupting Capacity of 138-Kv Oil Circuit Breakers. **W. B. Buchanan, G. D. Floyd**, Hydro-Electric Power Commission of Ontario

46-20. A New Line of High-Voltage Outdoor Tank-Type Oil Circuit Breakers. **W. F. Skeats, E. B. Rietz**, General Electric Company

46-21. Dielectric Recovery by an A-C Arc in an Air Blast. **T. E. Browne, Jr.**, Westinghouse Elec. Corporation

46-22. Long 60-Cycle Arcs in Air. **A. P. Strom**, Westinghouse Electric Corporation

9:30 a.m. Communication

46-7. Electronic Regeneration of Teleprinter Signals. **H. F. Wilder**, Western Union Telegraph Company

46-23. A Tunable Rejection Filter. **R. C. Taylor**, Western Union Telegraph Company

46-10. The Solution of Transmission-Line Problems in the Case of Attenuating Transmission Line. **George Glinski**, Northern Electric Company

46-24. Inertia Throat Microphones. **L. G. Pacent**, Pacent Engineering Corporation; **E. H. Greibach**, Sonotone Corporation

46-25. Laboratory Method for Objective Testing of Bone Receivers and Throat Microphones. **E. H. Greibach**, Sonotone Corporation

46-26. A New Crystal Channel Filter for Broad Band Carrier Systems. **E. S. Willis**, Bell Telephone Laboratories, Inc.

46-27. Applications of Thin Permalloy Tape in Wide Band Telephone and Pulse Transformers. **A. G. Ganz**, Bell Telephone Laboratories, Inc.

9:30 a.m. Conference on New Industrial Uses of Electronics Resulting From Wartime Developments

CP.* Hydrogen Thyratrons and Their Applications. **H. H. Heins**, Sylvania Electric Products, Inc.

CP.* Recent Developments of Magnetrons in the Microwave Region. **W. C. Brown**, Raytheon Manufacturing Company

CP.* Industrial Heating at Very High Frequencies. **I. E. Mouromtseff**, Westinghouse Electric Corporation

CP.* Progress and Trends in High-Frequency Heating. **H. C. Gillespie**, Radio Corporation of America

CP.* Use of Pulsers of the Radar Type for High-Potential Testing. **H. W. Lord**, General Electric Company

2:00 p.m. Symposium on Sound Recording and Reproducing

CP.* Wire Recording. **D. W. Pugsley**, General Electric Company

46-29. A New Wire Recorder Head Design. **T. H. Long**, C. G. Conn, Ltd.

46-30. A B-H Curve Tracer for Magnetic-Recording Wire. **T. H. Long, G. D. McMullen**, C. G. Conn, Ltd.

46-31. Signal and Noise Levels in Magnetic Tape Recording. **D. E. Wooldridge**, Bell Telephone Laboratories, Inc.

46-32. Phonograph Reproducer Design. **W. S. Bachman**, General Electric Company

● PAMPHLET reproductions of authors' manuscripts of the numbered papers listed in the program may be obtained as noted in the following paragraphs.

● ABSTRACTS of most papers appear on pages 29–35 of this issue and pages 454–6 of the December 1945 issue.

● PRICES and instructions for procuring advance copies of these papers accompany the abstracts. Mail orders are advisable, particularly from out-of-town members, as an adequate supply of each paper at the meeting cannot be assured. Only numbered papers are available in pamphlet form.

● COUPON books in five-dollar denominations are available for those who may wish this convenient form of remittance.

● THE PAPERS regularly approved by the technical program committee ultimately will be published in "Transactions"; many will appear in "Electrical Engineering."

46-33. ACO.** Recently Developed Tools for the Study of Disk Recording Performance. **H. E. Roys**, Radio Corporation of America

46-34. ACO.** Sound Recording in Business. **L. D. Norton**, Dictaphone Corporation

CP.* Technical Uses of Film Recording. **E. M. Honan** and **C. R. Keith**, Western Electric Company

2:00 p.m. Power System Relays

46-35. Protection of Pilot Wires From Induced Potentials. **R. B. Killen, G. G. Law**, The Dayton Power & Light Company

46-36. Linear Couplers—Field Tests and Experience at York and Middletown, Pa. **E. L. Harder, E. H. Klemmer**, Westinghouse Electric Corporation; **R. E. Neidig**, Metropolitan Edison Company

46-38. Application of the Ohm and Mho Principles to Protective Relays. **A. R. van C. Warrington**, General Electric Company

46-39. The MHO Distance Relay. **R. M. Hutchinson**, General Electric Company

2:00 p.m. Electric Welding

46-12. Investigation of Arc Starting Characteristics of D-C Welders with Reference to Electrode Freezing. **J. M. Tyrner**, Air Reduction Sales Company

46-18. Capacitor Stabilization of Arc Welding Transformers. **J. H. Blankenbuehler, R. V. Lester**, Westinghouse Electric Corporation

46-41. Design and Measurements of Condenser Discharge Welding Transformers. **T. W. Dietz**, The Taylor-Winfield Corporation; **G. M. Stein**, Westinghouse Electric Corporation

46-9. Measurement and Effect of Contact Resistance in Spot Welding. **R. A. Wyant**, Rensselaer Polytechnic Institute

Tuesday, January 22

9:30 a.m. Radar

46-46.† Radar Systems Considerations. **D. A. Quarles**, Bell Telephone Laboratories, Inc.

46-47.† Marine Radar for Peacetime Use. **L. H. Lynn, O. H. Winn**, General Electric Company

46-48.† Airborne Radar for Navigation and Obstacle Detection. **R. C. Jensen** and **R. A. Arnett**, General Electric Company

9:30 a.m. Protective Devices II

46-11. A New Submersible Network Protector of Higher Rating. **G. G. Grissinger, F. D. Johnson**, Westinghouse Electric Corporation

46-42. The Development, Design, and Performance of Magnetic-Type Power Circuit Breakers. **L. J. Linde**, formerly with General Electric Company; **B. W. Wyman**, General Electric Company

46-43. Metal-Clad, Unit-Type Switchgear for 33-Kv Service. **C. H. Kreger**, Public Service Company of Northern Illinois

46-45. New Series Capacitor Protective Device. **R. E. Marbury, J. B. Owens**, Westinghouse Electric Corporation

46-55. Size Reduction and Rating Extension of Magnetic Air Breakers up to 500,000 Kva, 15 Kv. **R. C. Dickinson, Russell Frink**, Westinghouse Electric Corporation

9:30 a.m. Conference on Industrial Voltage Requirements

CP.* Preliminary Report on industrial voltage requirements. Messrs. **Beeman, Grotzinge** and **French**

CP.* Grounding Industrial Power Systems. **L. G. Levoy**, General Electric Company

CP.* 2,300 Volts vs. High Voltages for, Power Generation and Distribution in Industrial Plants. **R. H. Kaufmann**, General Electric Company

45-156. Dielectric Strength and Protection of Modern Dry-Type Air-Cooled Transformers. **P. L. Bellaschi**, Westinghouse Electric Corporation

CP.* Transformer Ratios and Their Bearing on Industrial Voltage Requirements. **W. H. Dickinson**, Standard Oil Development Company; **John Parsons**, Westinghouse Electric Corporation

CP.* Industrial Voltage Requirements from the Utility Viewpoint. **R. C. R. Schulze**, American Gas and Electric Service Corporation

2:00 p.m. Conference on Quick and Slow Acting Relays

Will include talks by various people active in the field of relays for communications applications.

2:00 p.m. Radar

46-49.† Shoran Precision Radar. **S. W. Seeley**, Radio Corporation of America

46-50.† ACO.** SCR-584 and 784 Antiaircraft Radar Equipment. **M. R. Briggs**, Westinghouse Electric Corporation

46-40.† Techniques and Facilities for Microwave Radar Testing. **E. I. Green, H. J. Fisher, J. G. Ferguson**, Bell Telephone Laboratories, Inc.

*CP: Conference paper; no advance copies are available; not intended for publication in "Transactions."

**ACO: Advance copies only available; not intended for publication in "Transactions."

†These papers are subject to special clearance requirements; hence copies may not be available and prices are subject to change.

2:00 p.m. Conference on Power Relays

This conference will consider the relay protection of power-house auxiliaries and relay protection of transformers. A preliminary report summarizing information obtained from representative power companies, covering practices and experience on the protection of power-house auxiliaries, will be presented by E. L. Michelson, sponsor of the working group. The report covers types of supply systems, their protection, protection of 2,300-volt and lower voltage motors, and experience with protection systems. Preliminary to the preparation of a formal report, it is hoped that discussion in the conference from other companies will bring out operating experiences with protection schemes now used, new developments in motor protection, and differences in protection between essential and nonessential motors. On relay protection of power transformers a questionnaire to determine both existing and preferred practices has been circulated to a number of representative companies. The investigation covers types of protection customarily used with various sizes and kinds of transformers, with detailed analysis of differential protection, gas-accumulator and gas-pressure protection, thermal protection, fuse protection, and special applications.

CP.* Summary of Answers to the Questionnaire and Review of Available Protective Equipment. **W. R. Brownlee**, chairman, working group.

CP.* Clearing of Faults Involving Power Transformers. **W. E. Marter**, Duquesne Light Company

Discussion is desired regarding such topics as: the value of gas-accumulator protection, importance of the magnetizing-inrush-current problem, advantages of gas-pressure relays, and adequacy of available thermal protection devices.

2:00 p.m. Industrial Power Application

CP.* A Modern Industrial Network Installation **K. A. Fahse**, International Harvester Company

46-52. Combined Light and Power Systems for Industrial Plants. **D. L. Beeman**, General Electric Company

46-53. Induction Heating of Long Cylindrical Charges. **H. F. Storm**, Allis-Chalmers Manufacturing Company

46-54. Application of the Betatron to Practical Radiography. **J. P. Girard**, Allis-Chalmers Manufacturing Company; **G. D. Adams**, University of Illinois

6:30 p.m. Smoker—Hotel Commodore

Tickets, $6.50 each. Tables can be reserved for 6, 8, and 10 by remittance in advance. Important—make reservations now.

Wednesday, January 23

10:00 a.m. General Session

Edison Medal Presentation

Address: Development of Atomic Energy. Dr. J. R. Dunning, director, division of war research, Columbia University; technical advisor, The Kellex Corporation

2:00 p.m. Conference on Institute Activities

The Institute is confronted by problems of growing urgency both in its relations to the engineering profession at large and to more highly specialized organizations and interests within its own general field. Early this administrative year, the board of directors referred these problems to the committee on planning and co-ordination, who have appointed two special subcommittees to explore the profesional and the technical activities of the Institute in relation to those of other engineering and scientific societies and more particularly in relation to the desires and aspirations of the members of the Institute.

The relationship to other organizations is the easier part of the study. The desires and aspirations of the rank and file of the membership are more difficult of determination. This conference is intended as a first step toward finding out what a sample of the membership believes the Institute ought to be doing or ought to do in a different way.

Members active in Institute affairs should take this opportunity to assist the subcommittees by giving thought to the problems in advance of the conference, by attending the meeting and stating their considered opinions and specific suggestions. It is hoped that every District and every Section will be represented by at least one member but the meeting is open to all members and their views on these possible new frontiers of the Institute will be welcomed.

2:00 p.m. Conference on Standardization Activities of the Committee on Air Transportation

This conference will be conducted as an open meeting of the committee on air transportation. Members interested in this activity are invited to attend and take part in the discussion.

Agenda

Approval of minutes of meeting held January 24, 1945.

General discussion of standardization activities—J. R. North.

Reports of subcommittees and discussion:

(a) Aircraft Electric Systems. **R. H. Kaufmann**, *chairman*
(b) Aircraft Electric Control and Protective Devices. **R. A. Millermaster**, *chairman*
(c) Aircraft Wire and Cable. **W. S. Hay**, *chairman*
(d) Aircraft Electric Rotating Machinery. **M. L. Schmidt**, *chairman*
(e) Joint Subcommittee (Air-Transportation and Electric Machinery) on Carbon Brushes. **V. P. Hessler**, *chairman*

Discussion of one-year trial period of AIEE Report 700 on Standard Direct Voltages for Aircraft. Consideration of a subcommittee for a final Standard.

Discussion of possible additional subcommittees, particularly a subcommittee concerned with airline operation and its electrical problems.

Discussion of places for technical papers and for general committee work. Consideration of future meetings.

Discussion of the progress in the formation of technical discussion groups and of the value of such groups

New business:

(a) H. F. Rempt has suggested that the committee initiate a study of electrical fires in aircraft.

2:00 p.m. Conference on Machine Tool and Process Drives

CP.* Report of subcommittee on machine tool and process drives.

CP.* Machine Tool Drives. **H. T. Johnson**, General Motors Corporation

46-56. Co-ordinated Electric Drive for a Rubber Calender Train. **K. W. John**, U. S. Rubber Company; **G. W. Knapp, W. A. Mosteller**, General Electric Company

46-57. Industrial Application of Rototrol Regulators. **W. R. Harris**, Westinghouse Electric Corporation

8:00 p.m. Joint IRE-AIEE Session

Hoover Medal presentation to Major General William H. Harrison.

Address: Some Electrical Engineering and General Aspects of the Atomic Bomb Project. Major General Leslie R. Groves, United States Army

Thursday, January 24

9:30 a.m. Power Transmission

46-16. Lightning Performance of 220-Kv Transmission Lines—II. Lightning and Insulator Working Group

46-8. Formulas for Conductor Size According to Cost of Resistance Loss. **H. B. Dwight**, Massachusetts Institute of Technology

46-44. Arcing Ground Tests on a Normally Ungrounded 13-Kv, 3-Phase Bus. **J. E. Allen, S. K. Waldorf**, Pennsylvania Water & Power Company

46-37. Formulas for the Inductance of Coaxial Busses Comprised of Square Tubular Conductors. **H. P. Messinger**, Allis-Chalmers Manufacturing Company; **T. J. Higgins**, Illinois Institute of Technology

9:30 a.m. Electric Machinery I

46-58. Shutdown Versus Hot-Spot Temperatures in Polyphase Induction Motors. **C. P. Potter, A. E. Frohardt**, Wagner Electric Corporation

46-5. Transients in A-C Motors and Generators. **G. S. Smith**, University of Washington

46-59. The Polyphase Commutator Regulator for Speed Control. **A. G. Conrad**, Yale University; **F. E. Brooks, Jr.**, University of Texas

46-6. Temperature Rise of Water-Cooled Power Transformers. **J. R. Meador**, General Electric Company

9:30 a.m. Instruments and Measurements I

46-2. The Measurement of Large Varying Currents. **A. C. Johnson**, Edward G. Budd Manufacturing Company

46-62. Electronically Balanced Recorder for Flight Testing and Spectroscopy. **A. J. Williams, Jr., W. R. Clark, R. E. Tarpley**, Leeds & Northrup Company

46-17. Electrical Analogy Methods Applied to Servomechanism Problems. **G. D. McCann, S. W. Herwald, H. S. Kirschbaum**, Westinghouse Electric Corporation

46-60. Stress Measurement by Electrical Means. **R. E. Kern, S. B. Williams**, Curtiss-Wright Corporation

2:00 p.m. Electric Machinery II

46-63. Differential Leakage of a Fractional-Slot Winding. **M. M. Liwschitz**, Polytechnic Institute of Brooklyn

46-64. Die Cast Rotor Testing by Test Stator Method. **P. H. Trickey**, Diehl Manufacturing Company

46-65. Performance Calculations on Polyphase Reluctance Motors. **P. H. Trickey**, Diehl Manufacturing Company

46-66. The Short-Circuit Characteristics of D-C Generators. **G. E. Frost**, General Electric Company

2:00 p.m. Instruments and Measurements II

46-69. Thermal Demand Meter Testing Techniques. **E. E. Lynch, M. E. Douglass**, General Electric Company

46-68. Peak Voltages Induced by Accelerated Flux Reversal in Reactor Cores Operating above Saturation Density. **Theodore Specht, E. C. Wentz**, Westinghouse Electric Corporation

46-67. An Automatic Oscillograph with a Memory. **A. M. Zarem**, California Institute of Technology

2:00 p.m. Conference on Statistical Methods Applied to Standards

The purpose of the conference is to secure additional discussion on two papers, which have been published in ELECTRICAL ENGINEERING since the last winter meeting; to give further information regarding the work of the Standards subcommittee on statistical methods, and to receive suggestions for its future activities.

CP.* Quality Reports for Management Purposes. **Martin A. Brumbaugh,** University of Buffalo

CP.* Quality Control Through Product Testing. **P. L. Alger,** General Electric Company

45-142. Statistical Methods in the Development of Apparatus Life Quality. **E. B. Ferrell,** Bell Telephone Laboratories, Inc.

45-132. Statistics as an Aid to Engineering Judgment in the Manufacture of Lightning Arrester Blocks. **C. Goffman,** Westinghouse Electric Corporation

7:00 p.m. Dinner-Dance—Hotel Plaza

Tickets for dinner and dance, $8.00 per person. Limited number of tickets for dance only, $3.00 per person. Tables can be reserved for 8 and 10. Please send in reservations and remittances early.

Friday, January 25

9:30 a.m. Hydroelectric Systems

CP.* A Review of Features of Interest to the Electrical Engineer in the Design of Hydroelectric Power Plants. **A. H. Frampton,** Hydro-Electric Power Commission of Ontario

46-71. Supervisory Control of 30,000-Kva Hydro Plant. **C. W. Bohner,** General Electric Company; **A. P. Maness,** Tennessee Valley Authority

46-70. Technique of Electrical and Hydraulic Testing of Hydroelectric Units. **G. D. Floyd, J. J. Traill,** Hydro-Electric Power Commission of Ontario

CP.* Maintenance of Hydroelectric Generators. **L. B. Stirling,** Shawinigan Water & Power Company

CP.* Successful Conversion of Hydroelectric Plants to Semiautomatic Operation. **A. F. Ayres,** California Electric Power Company

9:30 a.m. Air Transportation I

46-14. Electrical Measurements on Aircraft Engine Ignition Circuits. **W. E. Berkey,** Westinghouse Electric Corporation

46-1. All-Electric Gun Charging. **W. C. Rohn,** Allied Control Valve Company

46-4. A Carbon Pile Speed Governor. **C. T. Button,** The Master Electric Company

9:30 a.m. Symposium on Lighting

Address: Advances in the Production and Application of Germicidal Radiation. **Dr. L. J. Buttolph,** General Electric Company

Address: Industrial Applications of Infrared Radiation. **Edwin H. Robinson,** The Fostoria Pressed Steel Corporation

Address: New Frontiers in Airport and Airway Lighting. **W. A. Pennow,** Westinghouse Electric Corporation, lighting division

Address: New Glassware in the Services of Lighting. **C. W. Clarkson,** Corning Glass Works

The foregoing addresses will be supplemented with demonstrations.

9:30 a.m. Symposium on Nuclear Energy

Address: Physics of Nuclear Energy. **K. K. Darrow,** Bell Telephone Laboratories, Inc.

Address: Economic Aspects of the Application of Nuclear Energy. **Philip W. Swain,** editor, *Power,* McGraw-Hill Publishing Company

Address: Peacetime Applications of Nuclear Energy. **C. G. Suits,** vice-president and director of research, General Electric Company

2:00 p.m. Excitation Systems

46-78—ACO.** Excitation Systems for Synchronous Machines. **S. B. Crary, J. B. McClure,** General Electric Company

46-76—ACO.** Excitation Systems for Turbine Generators. **M. D. Ross,** Westinghouse Electric Corporation

46-77. Motor-Driven Exciters for Turbine Alternators. **R. B. Bodine, S. B. Crary, A. W. Rankin,** General Electric Company

46-74. Application and Performance of Electronic Exciters for Large A-C Generators. **H. A. P. Langstaff,** West Penn Power Company; **H. R. Vaughan, R. F. Lawrence,** Westinghouse Electric Corporation

46-75. Electronic Generator Voltage Regulator. **J. E. Reilly, C. E. Valentine,** Westinghouse Electric Corporation

46-73—ACO.** The Design of an Electronic Exciter for Large Generators. **W. R. Farley, C. R. Marcum,** Westinghouse Electric Corporation

2:00 p.m. Air Transportation II

46-3. Basic Design Principles for A-C Electrical Power Systems in Large Military Aircraft. **C. K. Chappuis,** United States Army Air Forces; **L. M. Olmsted,** Air Technical Service Command

46-13. Pressure-Arc-Interruption Circuit Breakers for 400-Cycle Aircraft Electric Power System. **B. O. Austin,** Westinghouse Electric Corporation

46-79. Governor for Variable Ratio Transmission Used in Developmental 400-Cycle Electrical System for Large Aircraft. **P. F. Desch, D. E. Garr, J. G. Hutton,** General Electric Company

46-15. Effect of Altitude on Ventilation and Rating of Aircraft Electric Machines. **C. G. Veinott,** Westinghouse Electric Corporation

2:00 p.m. Conference on Education

The objective of this conference is to review the experiences which private industries and Governmental agencies have had with electrical engineering graduates in a civilian status during the war so that possible changes in the engineering curricula of colleges and universities may be considered promptly. Due to the shortage of recent graduates and younger engineers in war industries the engineer has had to learn to work effectively with engineering aids and technicians. In war research agencies engineers have had to co-operate with physicists to a greater extent than ever before. Arrangements are being made to explore the borderline relationships between the several groups mentioned.

6:00 p.m. IRE Party at Hotel Astor

Winter Convention Program Will Explore New Frontiers of Electrical Engineering

With a view toward the future the program for the winter convention to be held in New York, N. Y., January 21–25, 1946, will feature 29 technical sessions and conferences, which will explore the new frontiers of electrical engineering in the fields of power, communication and electronics, industrial applications, and air transportation. A prominent nuclear physicist of broad vision will address the general session on the development of atomic energy. Before the joint meeting with the Institute of Radio Engineers some of the electrical engineering and general aspects of the atomic-bomb project will be given in an address by the military head at that project. In addition, a symposium on nuclear energy has been arranged and well-known speakers will consider the physics applications and economics. The program is replete with both technical and social activities with the prewar features restored. Convention headquarters will be in the Engineering Societies Building, 33 West 39th Street. Early registration is recommended. Registration will be strictly enforced by the showing of badges for admission to technical sessions, and the nonmember fee of $2.00 for registration will be required.

EDISON MEDAL PRESENTATION

One of the features of the general session will be the presentation of the Edison Medal to Philip Sporn (F '30) executive vice-president and chief engineer, American Gas and Electric Service Corporation, New York. The medal was awarded "for his contributions to the art of economical and dependable power generation and transmission."

HOOVER MEDAL PRESENTATION

One of the features of the joint meeting with the IRE will be the presentation of the Hoover Medal to Major General William H. Harrison (F '31) vice-president, in charge of operation and engineering, American Telephone and Telegraph Company, New York, and recently major general, Army of United States. The medal was awarded with the citation: "William Henry Harrison, who in times of peace has been devoted to his civic services and effective in his recognition of the essentials of human betterment, and who equally in time of war, inspired by the same ideals, has generously served his country, is awarded by his fellow engineers the Hoover Medal for 1945."

ENTERTAINMENT

The oldtime entertainment features are back, including the dinner-dance at the Plaza Hotel, smoker at the Commodore Hotel, and inspection trips. For details of these events see *Electrical Engineering,* December, 1945, page 452. One of the trips will cover an inspection of installations at LaGuardia Field, with flights over the city and vicinity. This trip will be on Tuesday, January 22. Flights will be from 10:00 a.m. to 4:00 p.m. on the hour, 45 minutes in the air. Tickets will be $5.00 each, plus 15 per cent tax, and reservations must be made in advance.

WOMEN'S ENTERTAINMENT

A women's entertainment committee, under the chairmanship of Mrs. J. F. Fairman, is engaged actively in making arrangements for the women who will attend the convention. A luncheon with bridge and a fashion show has been arranged at the Hotel Pierre on Wednesday, January 23. Tickets are $4.00 each. Please make reservations in advance.

HOTEL ACCOMMODATIONS

The hotel situation in the metropolitan area is acute and quite likely will remain so for some time. Members, therefore, are urged to make their plans early and arrange for accommodations directly with the hotel preferred. The Institute has no connections with any of the hotels and cannot undertake to make reservations.

WINTER CONVENTION COMMITTEE

The personnel of the committee making arrangements for the convention are as follows: C. S. Purnell, *chairman;* J. L. Callahan, M. D. Hooven, R. A. Jones, A. E. Knowlton, J. H. Pilkington, J. J. Pilliod, C. C. Whipple. Subcommittee *chairmen:* E. E. Dorting, publicity, AIEE; C. T. Hatcher, smoker; H. H. Heins, theater tickets; G. J. Lowell, dinner-dance; R. T. Oldfield, inspection trips.

ETA KAPPA NU DINNER

On the first evening of the convention, Monday, January 22, the New York alumni chapter of Eta Kappa Nu will have its annual dinner. This year the dinner will be in honor of the 70th birthday of Vladimir Karapetoff (F '12) professor emeritus of electrical engineering, Cornell University, Ithaca, N. Y. The dinner will be held at 6:30 p.m., at Rosoff's Restaurant, 147 West 43rd Street, New York.

Reconversion Required for "Inactive Membership Status"

Members who went on "inactive" AIEE status incidental to military or Merchant Marine service during World War II are eligible for reinstatement to full membership privileges without formality. The only requirement is a letter of notification from the individual to the membership department at AIEE headquarters within 90 days of termination of such service.

By action of the AIEE board of directors January 28, 1943 (*EE, Mar '43, p 118–19*) the option was extended to all members in good standing to continue full membership status, or to become an "inactive member" without payment of dues and without receiving regular publications. The board further provided that "such inactive members will be expected to resume active membership within three months after their severance from war service, with the same status in all respects as existed at the time of entering the service." Similarly, Student members on inactive status may be restored to appropriate active status upon written notification to headquarters.

Future AIEE Meetings

Winter Convention
New York, N. Y., January 21–25, 1946

South West District Meeting
San Antonio, Tex., April 16–18, 1946

North Eastern District Meeting
Buffalo, N. Y., April 24–26, 1946

Southern District Meeting
Asheville, N. C., May 14–16, 1946

Summer Convention
Detroit, Mich., June 24–28, 1946

Pacific Coast Convention
Seattle, Wash., in week of August 26–30, 1946

Great Lakes District Meeting
Fort Wayne, Ind., September 25–27, 1946

Personnel of Section membership committees and other active AIEE members can perform a valuable service to presently "inactive members" by reminding them of the necessity for individual action to restore full membership status.

Protective Devices Committee Discusses Future Activities

At a meeting of the AIEE protective devices committee in Pittsburgh, Pa., November 16, 1945, each of the five subcommittees reported on organization of their activities for the coming year. H. H. Rudd (A '18) chairman of the newly formed subcommittee on switches, fuses, and insulators, proposed consolidating standards, covering various devices. This proposal was considered favorably and a working group was assigned the preparation of the necessary material. It was pointed out that in many ways the circuit breaker Standard C37.4 might serve as a guide for the new consolidated standards on switches, fuses, and insulators.

ABSTRACTS • • •

TECHNICAL PAPERS previewed in this section will be presented at the AIEE winter convention, New York, N. Y., January 21–25, 1946, and will be distributed in advance pamphlet form as soon as they become available. Copies may be obtained by mail from the AIEE order department, 33 West 39th Street, New York 18, N. Y., at prices indicated with the abstract; or at five cents less per copy if purchased at AIEE headquarters or at the convention registration desk.

Mail orders will be filled AS PAMPHLETS BECOME AVAILABLE

Air Transportation

46-79—Governor for Variable Ratio Transmission Used in Developmental 400-Cycle Electric System for Large Aircraft; *P. F. Desch, D. E. Garr (M '45), J. G. Hutton. 15 cents.* The trend in both civil and military aircraft is toward larger machines requiring large amounts of electric power. Much thought and discussion in recent years have been given to an a-c system which would have the generators driven by the main engines and operating in parallel. Since flight conditions may demand more than a 3 to 1 speed range, it is essential that some form of variable ratio transmission be coupled between each prime mover and generator, so that a parallel system at substantially constant frequency is practical. Automatic control of the transmission would be necessary to maintain each generator within the range required in spite of high acceleration and wide speed differences of the prime movers. An electric governor, which maintained successful parallel operation of the generators and equality of load division under various conditions of acceleration and loading, was developed. The paper describes the governor and its control circuits and presents experimental data obtained during performance tests.

Basic Sciences

46-37—Formulas for the Inductance of Coaxial Busses Comprised of Square Tubular Conductors; *H. P. Messinger (A '43), T. J. Higgins (A '40). 30 cents.* Formulas are derived for calculating the inductance of single-phase coaxial busses comprised of square tubular conductors. It is assumed that the conductors are nonmagnetic, are of such length that end effects are negligible, are uniformly thick, are right-cornered, and carry currents uniformly distributed over their cross sections. The general formula is obtained through use of geometric mean distance theory. A simple approximate formula, the conductors being considered as indefinitely thin, is epitomized in curves which yield values sufficiently accurate for most design work. Use of these formulas and curves is illustrated by calculating the inductances of typical busses. The increase in inductance due to rounding the edge of the conductors and the decrease produced by skin and proximity effects are investigated. The former can be approximated by use of a known formula; the latter appears to be negligible at power frequencies. Calculation of the inductance of coaxial busses constructed of tubular conductors made up of two channels or angles placed flange to flange is discussed. Illustratively, the inductance of such a bus is calculated and found to be in good agreement with the known experimental value. Finally, procedure for calculating the inductance of polyphase coaxial busses is outlined.

Communication

46-23—A Tunable Rejection Filter; *R. C. Taylor (A '30). 20 cents.* In carrier telegraph systems using modulators and pilot channels carrier leak and stray pilot frequencies require removal with a minimum

of disturbance to other parts of the system. This paper describes a device to accomplish this result, using a Wheatstone bridge circuit whose capacitor elements may be adjusted to reject any frequency in a range of the order of two to one. Attenuation formulas are derived for both the stop and pass regions and a graphical method for experimental use described. The use of two sections in tandem to secure a greater width of rejection band is discussed, and a formula for the combined width is derived.

46-24—Inertia Throat Microphones; *E. H. Greibach (M '43), L. G. Pacent (F '30). 15 cents.* This paper deals with the theory and design of magnetic inertia throat microphones. Especial attention is given to the treatment of sound power and high articulation throat microphones. The sound power microphones described contain a double-frequency undamped vibrating system, while the high articulation microphones have damping introduced, which reduces the low-frequency peak with resultant increase in articulation. Wide-range frequency response is obtained from the neighborhood of 100 cycles extending up to 3,000, 4,000, or 5,000 cycles, as may be desired. These microphones have a band-pass filter character with a sharp high-frequency cutoff. This cutoff is desirable in order to cut out high-frequency noises.

46-25—Laboratory Method for Objective Testing of Bone Receiving and Throat Microphones; *E. H. Greibach (M '43). 15 cents.* This paper describes a mass-controlled device usable both as artificial throat and mastoid microphone. The design of the device enables one to obtain consistent results, regardless of position on the platform of units under test. Uniform distribution of velocity from 50 to 10,000 cycles permits easy interpretation of data obtained with this equipment. Data, in the form of frequency-response curves, are recorded automatically. Diagrams of setups are shown.

46-26—A New Crystal Channel Filter for Broad-Band Carrier Systems; *E. S. Willis (A '45). 15 cents.* This paper describes a new crystal channel filter used in broad-band carrier telephone systems. The filter requires less than two thirds as much mounting space and weighs less than half the earlier design. Substantial savings in material and manufacturing effort also are realized. These savings were accomplished by assembling the four crystal units in one lattice-type filter section rather than two, resulting in a reduction in the number of component coils and capacitors. The use of this compact filter configuration was made possible by the development of wire-supported mountings in place of the earlier clamp-type mountings for crystal units, greatly improving their stability of performance.

46-27—Applications of Thin Permalloy Tape in Wide-Band Telephone and Pulse Transformers; *A. G. Ganz (A '35). 25 cents.* The use of thin permalloy ranging from 2 mils to as little as 1/8 mil thick in tape cores and the advantages of this core construction are described. Typical applications in wide-band telephone transformers, pulse transformers, and nonlinear coils are discussed. Data are given on the steady-state a-c properties of thin tape up to 1 megacycle. Pulse magnetization of the tape is analyzed. The available flux density range with unidirectional pulses and the effects of appropriate air gaps and of reverse magnetization between pulses are illustrated. Equations are given for flux distribution, effective permeability, and loss, assuming linear magnetic properties, and convenient graphs for these characteristics are included. Simple expressions are developed for effective permeability and loss, which are approximations to the high d-c permeability and rapid transition to saturation characterizing the permalloys.

46-29—A New Wire-Recorder-Head Design; *T. H. Long (M '44). 15 cents.* Certain defects inherent in the usual design of wire-recorder heads are pointed out. Some defects are of a practical nature and one is based on theoretical considerations. An improved design is proposed on which a limited amount of experience has been obtained. A natural modification of this design permits level winding across the record-playback head, thus distributing the wear and resulting in a head that is virtually self-cleaning.

46-30—A B–H Curve Tracer for Magnetic-Recording Wire; *T. H. Long (M '44) G. D. McMullen. 15 cents.* The equipment described is able to show on the screen of an oscilloscope the cyclic hysteresis loop of a sample of magnetic-recording wire little over one inch long and with a very useful degree of accuracy. Results obtained with the equipment in studying recording wires are given. A discussion is included of the operation and of possible modifications.

46-31—Signal and Noise Levels in Magnetic Tape Recording; *D. E. Wooldridge. 30 cents.* The primary object of the work described in this paper was to determine what properties of the tape and associated magnetic elements are responsible for the noise and signal output levels of perpendicular magnetic recordings and, where possible, to display in specific equations the pertinent relationships connecting noise and signal levels with the physical properties of the tape and polepieces. In the course of the study methods appeared for decreasing the noise and increasing the useful signal reproduced from magnetic tape. These methods and some of the use that Bell Telephone Laboratories and Western Electric have made of them are mentioned in the discussion.

46-32—Phonograph Reproducer Design; *W. S. Bachman. 15 cents.* The development of two new phonograph reproducers is described. One, a variable resistance type, employs a polarized strain-sensitive-wire resistance generator element. The other is a variable reluctance or magnetic type. Both of these reproducers have low mechanical impedance at the stylus tip made possible by the use of extremely small moving mass, high suspension compliance, and a new technique for damping the resonance of the supporting arm mass with the suspension compliance.

46-33—Recently Developed Tools for the Study of Disk-Recording Performance; *H. E. Roys. 20 cents.* Equipment developed for the study of disk-recording performance permits measurements of the force existing at the tip of the recording stylus while cutting an unmodulated groove in lacquer. Variations in cutting force have been observed due to oscillation of the recording head and to use of an advance ball. Torque requirements of turntable driving motor depend upon the cutting force. Inertia of the turntable is useful in maintaining speed constancy and in overcoming the effect of the variable cutting load. Measurements show a loss of recorded amplitude due to loading of the lacquer on the stylus tip. The load varies with groove velocity, and its effect depends upon the mechanical impedance of the recording head. Distortion testing by the intermodulation method has been found useful. Worn styli can be detected readily. Good correlation between measurements and what the ear hears has been obtained.

46-34-ACO—Sound Recording in Business; *L. D. Norton. 20 cents.* The earliest practical application of sound recording was for business purposes. A brief history of its development is outlined, and modern specialized business applications are discussed. The chief design factors with regard to dictation equipment are convenience and ease of handling, high intelligibility, and dependability. Intelligibility is discussed in terms of frequency range and response, component limitations, and mechanical factors of machine operation. Convenience to the user is stressed, and modern office machines are described in examples. Descriptions are given of various recording media, such as wax cylinders, plastic compositions, and magnetic materials.

46-40—Techniques and Facilities for Microwave Radar Testing; *E. I. Green (M '30), H. J. Fisher (A '38), J. G. Ferguson (M '20). 30 cents.* Methods and devices are described for testing microwave radars in the radio frequency range from about 500 megacycles to 25,000 megacycles and at associated video frequencies. In general the same instruments and techniques are applicable also in testing microwave communication systems.

46-46—Radar Systems Considerations; *D. A. Quarles (F '41). 25 cents.* In this paper a radar system is viewed as an assembly of functional circuits and parts, each highly developed to perform its particular role in the system. The over-all

performance characteristics are dependent both on the excellence of these parts and the nicety with which they are fitted together and co-ordinated in the system plan. It is the present purpose to discuss some of these system planning considerations with examples of practical solutions.

46-47—Marine Radar for Peacetime Use; *L. H. Lynn, O. G. Winn (A '43). 15 cents.* The essential differences between military and peacetime radar are discussed and desirable design features derived. Basic circuits and construction of the Electronic Navigator, one design being made which embodies these features, are described.

46-48—Air-Borne Radar for Navigation and Obstacle Detection; *R. C. Jensen, R. A. Arnett (A '43). 20 cents.* The grim uses of radar in war now are giving way to a peacetime role in navigation and obstacle detection. This article discusses the results obtained with military air-borne radar as a basis for understanding both the possibilities and the limitations in applying radar to reduce aviation hazards.

46-49—Shoran Precision Radar; *S. W. Seeley. 25 cents.* Shoran navigational radar generally is credited with being the most precise system of its type devised by man. Recent military declassification permits the exposition of the history of the conception and development of the principles employed, as well as a description of the physical make-up of the equipment.

46-50-ACO—The SCR-584 and SCR-784 Equipments; *M. R. Briggs. 15 cents.* This paper describes in general terms the employment, basic characteristics, and physical construction of the SCR-584 and the SCR-784, two of the most outstanding radar sets developed during the war. Originally designed for antiaircraft fire control, their adaptability enabled them to fill many other tactical requirements. Both are capable of automatic tracking of a target in elevation and azimuth, and the SCR-784 of tracking automatically in range.

Electric Machinery

46-58—Shutdown Versus Hot-Spot Temperatures in Polyphase Induction Motors; *C. P. Potter (F '29), A. E. Frohardt (A '45). 15 cents.* The "Test Code for Polyphase Induction Machines AIEE 500" requires that the temperature rise of a motor taken either while running or at any time after shutdown must not exceed the value stamped on the name plate. This paper shows that the permissible shutdown temperature rise is a function of the degree of enclosure and that in present-day 40 degrees centigrade motors the allowable shutdown temperature rise should be 45 degrees centigrade instead of 40 degrees centigrade and recommends that such a change be made in AIEE 500 and ASA C-50.

46-59—The Polyphase Commutator Regulator for Speed Control; *A. G. Conrad (M '40), F. E. Brooks, Jr. (A '44), R. G. Fellers (A '44). 30 cents.* This paper presents an explanation of the theory and explains the characteristics of an a-c adjustable-speed drive obtained by using a polyphase commutator regulator mechanically coupled to the shaft of a wound-rotor induction motor and electrically connected to its slip rings. The theoretical loci of the system current vectors with respect to the voltage vectors of the induction motor are developed in terms of the constants of the machines and the applied voltage. A method of determining the characteristics of the drive from no-load tests or from design data is presented. The characteristics predicted on these bases are in excellent agreement with experimental ones.

46-63—Differential Leakage of a Fractional-Slot Winding; *M. M. Liwschitz (M '39). 15 cents.* In a previous paper published in the AIEE *Transactions*, the differential leakage of an integral-slot winding and squirrel-cage winding has been treated on the basis that the influence of slot openings is the same for all harmonics, that is, that all harmonics are reduced by the slot openings in the ratio of 1 to the Carter factor, and that the micromicrofarad curve has a stepped shape. In this paper the influence of the slot openings on the individual harmonics and the trapesoidal shape of the micromicrofarad curve are considered and formulas for the differential leakage of a fractional-slot winding are derived. It is shown that a relatively simple method of calculation of the differential leakage can be used, since the error due to the reduction of all harmonics by the Carter factor is approximately equal and opposite to the errors due to the neglect of damping by the rotor and assumption of stepped micromicrofarad curve.

46-64—Die Cast Rotor Testing by Test Stator Method; *P. H. Trickey (M '36). 15 cents.* Although the die cast induction motor rotor is ideal in its ruggedness, simplicity, and durability, it has the characteristic of hiding any interior defects under a perfect outside surface. A testing means, however, is obtained by constructing and calibrating a special stator and using it to take a locked-rotor reading on the rotor to be tested. The test stator is made of exceptionally large outside diameter with particularly large slots, allowing very large coils and small copper losses. A large air gap allows unfinished rotors to be inserted for test. Particular care is used in testing and analyzing the stator for circuit constants. With these calibration curves are calculated, and test limits are set.

46-65—Performance Calculations on Polyphase Reductance Motors; *P. H. Trickey (M '36). 15 cents.* The general equations given by Doherty and Nickle in their classic synchronous-motor paper have been rearranged omitting the terms having to do with field excitation, and a simple straightforward calculation sheet or form has been devised. Extensive calculations have been made and curves drawn up which may be used to calculate readily the synchronous pull-out torque.

46-66—The Short-Circuit Characteristics of D-C Generators; *G. E. Frost (A '41). 30 cents.* D-C machine characteristics under short-circuit conditions are described in terms of transient resistance, synchronous resistance, and transient field time constant. These constants are based on neglecting armature inductance and representing the machine steady-state volt-ampere characteristic by a straight line approximation and are analogous in many respects to the corresponding synchronous machine constants. The calculation and application of these machine constants are illustrated for the specific case of a 60-kw 240-volt d-c generator. The influence of series fields, compensating windings, and fault resistance on short-circuit current is considered in some detail. It is shown that series windings have no effect on peak short-circuit current but do influence the steady current value. Compensating windings, which theoretically give very high peak short-circuit current, are shown to be relatively ineffective in actual machines. Formulas are given whereby short-circuit current under various values of fault resistance may be calculated. Mathematical relations forming a basis for the machine constants are included in the appendixes.

Electric Welding

46-18—Capacitor Stabilization of Arc-Welding Transformers; *J. H. Blankenbuehler (M '40), R. V. Lester. 15 cents.* This paper discusses a method of improving the arc stability with a-c welding transformers and a method of measuring relative arc stability. After a method of comparing the arc stability is developed. How this method is used is explained to determine the effectiveness of a method of lowering the no-load voltage of an arc-welding transformer by shunting a capacitor across the output terminals. This method of improving the arc stability with a given transformer voltage is shown to make it possible to achieve excellent welding performance with transformers having no-load terminal voltage of 65 volts. Curves and oscillograms showing the operation of the stabilizing system are shown in the paper.

46-41—Design and Measurements of Capacitor-Discharge Welding Transformers; *T. W. Dietz, G. M. Stein (M '38). 20 cents.* A capacitor discharge by way of a welding transformer is used to supply a closely controlled energy to the welding spot. The paper describes the design of this transformer on the basis of test results of resistance and inductance obtained from a finished welding unit by oscillograms of the current and voltage. In addition to this, a number of equations are derived from the analysis of the circuit. These formulas

allow explicit calculation of the transformer dimensions from the measured components of the impedance. For this purpose some new circuit elements are introduced, which can be taken directly from a graph. The method also takes advantage of the residual flux in the transformer. After each discharge, the polarity of the transformer is reversed, so that its flux capacity is increased by this residual flux.

Electronics

46-54—Application of the Betatron to Practical Radiography; *J. P. Girard (A'45), G. D. Adams. 20 cents.* The betatron which accelerates electrons by magnetic induction was developed into a workable machine by Doctor D. W. Kerst at the University of Illinois. This machine is the latest step in the production of higher energy X rays, as the voltages necessary to produce these X rays are very low, so that insulation is not the limiting factor in the energies which can be attained. Under supervision of the Office of Scientific Research and Development the betatron was developed from a physics laboratory apparatus to an industrial radiographic machine. The best energy for industrial radiography was found to be 20,000,000 electron volts, and betatrons having this maximum energy have been installed which are capable of detecting small flaws in as much as 20 inches of steel or other heavy metal. This paper discusses the development and application of this machine and the radiographic properties of the X rays produced.

Induction and Dielectric Heating

46-53—Induction Heating of Long Cylindrical Charges; *H. F. Storm (A'42). 30 cents.* A previous paper by the author offered a new approach for the analysis of the induction-heating effect by using concepts commonly applied to a-c engineering and without involving differential equations. A limitation of that paper consisted in the assumption that the radius of the charge will be very large in comparison with the depth of penetration. It is the object of this paper to cast off the aforementioned limitation and hence provide an analysis which is valid for any size of the radius of the charge and the depth of penetration. The generated heat is expressed in terms of rapidly converging series. The analysis finally is applied to the case where the charge is subdivided into a number of cylindrical rods.

Industrial Power Applications

46-52—Combined Light and Power Systems for Industrial Plants; *D. L. Beeman (M'43). 15 cents.* The upward trend in illumination levels in industrial plants has resulted in an increased power demand of the lighting load. Illumination levels of 50 foot-candles are in general considered good practice at the present time, with some thinking of illumination levels as high as 100 foot-candles. The lighting load is a sizable portion of the total plant load. In many average manufacturing plants the lighting load will represent 2 to 4 volt-amperes per square foot, and the power load 8 to 10 volt-amperes per square foot. The same technique that has been applied in distributing power to machine tools and other power loads will pay dividends in distributing power to the lighting load. Systems of 120 volts have been used almost universally for incandescent lamps. Higher voltage incandescent lamps are fragile and generally not satisfactory. With the introduction of fluorescent lamps the 120-volt restriction no longer applies. All fluorescent lamps have ballasts in series with them. By combining a slight transformer action with the ballast, the fluorescent lamp ballast can be supplied at any voltage from 120 to 260 volts. The industry, however, has standardized on the following ballast ratings: 118, 208, 230, and 260 volts. The introduction of higher voltage fluorescent lamp ballasts has opened new avenues for using higher voltage lighting circuits, thereby reducing the cost of the power system which supplies the lighting load. The trend toward load center power distribution systems also has enabled the use of combined light and power systems for industrial plants. This paper outlines the economy of combined light and power systems and higher voltage lighting circuits.

46-56—Co-ordinated Electric Drive for a Rubber Calendar Train; *K. W. John (M'41), G. W. Knapp (A'45), W. A. Mosteller. 20 cents.* The continuous process of coating fabrics with rubber, such as is used in tire manufacturing, involves several individual machines that present operating problems not successfully met by mechanical drives. A new, co-ordinated electric drive has been developed which does meet these requirements using Amplidyne, and also electronic, control. It is expected that quality and production will be improved by this equipment. The means employed may be applied successfully to other industries.

46-57—Industrial Application of Rototrol Regulators; *W. R. Harris (M'44). 20 cents.* The Rototrol has been applied in considerable numbers to a wide variety of industrial applications. It has met adequately the need for a simple and reliable regulator which is capable of withstanding the rigors of general industrial usage and which is sufficiently elemental in operation that it can be understood by nontechnical maintenance personnel. It has been accepted enthusiastically by industry, and applications in both existing and new fields are rapidly increasing. This paper discusses the fundamental theory of the Rototrol, the application of the circuits most commonly used, and cites operating results for typical installations.

Instruments and Measurements

46-17—Electrical Analogy Methods Applied to Servomechanism Problems; *G. D. McCann (M'44), S. W. Herwald, H. S. Kirschbaum (A'43). 15 cents.* The various electrical–mechanical analogies of angular-position servomechanisms are developed so that their performance can be analyzed by electric circuits. A description is given of auxiliary amplifier circuits that have been developed to be used in conjunction with the mechanical transients analyzer in setting up the electrical analogies. With these facilities complete transient solutions can be obtained quickly for a wide variety of servomechanisms. Response to any arbitrary control can be studied. All parameters such as time delays, stiffness, damping, and feedback can be simulated and easily varied. Typical solutions are given.

46-60—Stress Measurement by Electrical Means; *S. B. Williams (A'38), R. E. Kern (A'45). 30 cents.* Approval of a structural member from a strength standpoint requires that the critical stresses or strains indicative of the successful operation of the test piece be accurately measured and be interpreted according to an appropriate theory of failure. The ability of the test personnel to comprehend the mechanical as well as the electrical approaches to the problem is an important adjunct to the procurement of pertinent and reliable results. A large portion of current strength testing of finished products is accomplished by means of resistance measurements on fine-wire filaments bonded to the surface of the test element. The background essential to the most effective use of such a gauge includes

1. Knowledge of the product designer's problem together with some of his methods of gauge data analysis.
2. Familiarity with gauge installation, operation, and circuit theory.
3. Experience with a wide variety of indicating and recording instruments.

46-62—Electronically Balanced Recorder for Flight Testing and Spectroscopy; *A. J. Williams, Jr. (M'45,) W. R. Clark (M'44), R. E. Tarpley (A'29). 15 cents.* A multiple-point potentiometer recorder for thermocouples is described having a slide wire driven to balance by a small induction motor powered from a 6L6 electron tube. The preamplifier gain is sufficient that the conventional input transformer (voltage step-up type) is not requird, and thus a high impedance input circuit is made available. This permits the use of small capacitance values in the *RC* circuits for signal filtering and motor damping. The relation of this to the short balancing time (1.5 seconds) is discussed. Spectroscopy supplied the incentive for the development of two additional but similar recorders. The first of these is a curve-drawing multiple-range microampere recorder with the smallest range 0.5 microampere and with a balancing time of less than 1.0 second. The second is a multiple-range current-ratio recorder requiring only about 10 microamperes for the reference current.

46-67—An Automatic Oscillograph With a Memory; *A. M. Zarem (A'43). 15 cents.* It is frequently necessary to study

transient phenomena which occur spontaneously or at irregular intervals. In many cases it is not possible to reproduce these circuit disturbances artificially, and consequently such transients cannot be investigated at leisure. Furthermore, it is sometimes of prime importance to obtain information concerning circuital conditions immediately preceding the advent of a transient. This paper describes an instrument which can record automatically electrical conditions before, during, and after the occurrence of a transient. It consists of a 3-tube cathode-ray oscillograph, a beam blanking circuit, an electronic control circuit, and an automatic camera. The persistence of fluorescence, which is characteristic of cathode-ray tube screens, is utilized to obtain electrical memory. The utility of the instrument is illustrated by several photographic records of transients which may occur during the operation of a mercury-arc polyphase converter.

46-68—Peak Voltages Induced by Accelerated Flux Reversal in Reactor Cores Operating Above Saturation Density; *Theodore Specht* (*A '41*), *E. C. Wentz* (*M '42*). *30 cents.* When induction apparatus with an iron magnetic circuit carries an alternating current in excess of that necessary to saturate the core, the voltage induced in the apparatus takes on a peaked wave shape rather than the usual sinusoidal shape. Methods of calculation are developed for calculating the peak voltage, including the effect of system impedance, system voltage, and eddy losses in the iron core of the apparatus. Formulas also are developed to show the effect of the crowding of the flux to the surface of the steel at very high rates of change of flux. The effect of shunting the apparatus with a resistor also is developed. A comparison is made between calculated and test values, and data included giving the peak voltages developed by typical current transformers when operated with their secondaries open-circuited.

46-69—Thermal Demand Meter Testing Techniques; *E. E. Lynch* (*M '35*), *M. E. Douglass.* *20 cents.* Thermal demand meters have inherent characteristics which have necessitated testing techniques applicable particularly to these meters. The fact that the tests consumed considerable time has not been considered to be particularly important, since thermal meters have been returned to the laboratory and gang tested. However, with the advent of more accurate types of thermal meters and because they require a minimum of maintenance, their more widespread use is being considered, and testing methods more nearly resembling those of the mechanical type will be desired. Thus it is to be expected that more attention will be given to new testing techniques which will minimize testing time. This paper is written to encourage thinking and development along these lines, and it shows that shorter testing methods can be devised for use with thermal demand meters having easily predictable time-deflection characteristics, such as the simple exponential.

Power Generation

46-70—Technique of Electrical and Hydraulic Testing of Hydroelectric Units; *G. J. Floyd* (*M '28*), *J. J. Traill.* *20 cents.* This paper discusses the application of the recently issued "AIEE Test Code for Synchronous Machines" to acceptance testing of hydraulic-type generators, stating which methods of testing given in the test code can be used and the reasons why other methods are difficult or unsuitable for this type of generator. The acceptance tests on the prime mover are outlined in sufficient detail to permit an understanding of the fundamentals, and the relation of and accuracy required in electrical measurements on the associated generator are briefly outlined. Other hydraulic tests made on the hydroelectric unit are included to illustrate the value of such tests in establishing the performance of the unit as a whole.

46-71—Supervisory Control of 30,000-Kva Hydroelectric Plant; *C. W. Bohner* (*M '42*), *A. P. Maness* (*A '36*). *15 cents.* Ocoee 3, a one-unit 30,000-kva supervisory-controlled generating station of the Tennessee Valley Authority, has been in operation since April 30, 1943. An underground cable was selected for the control and telemetering channel, and neutralizing transformers were installed to protect against voltage rise resulting from transmission line faults. Instrumentation, controls, and station auxiliaries were designed particularly to safeguard the unattended equipment. Maintenance includes two or three inspections per week. The cost of supervision, operation, and maintenance is as low as $0.101 per 1,000 kilowatt-hours.

46-73-ACO—The Design of an Electronic Exciter for Large Generators; *W. R. Farley*, *C. R. Marcum* (*A '43*). *20 cents.* This paper describes the design of an electronic exciter, comprising an ignitron rectifier and associated switchgear. For such an application continuity of service is of the utmost importance. The equipment is arranged so that various portions may be de-energized for maintenance without interrupting service. Circuit breakers, opening due to ignitron arc-backs, are arranged for automatic reclosing. An audible alarm and identifying visual signals are provided in the event of apparatus abnormalities. A voltage regulator rapidly varies the electronic exciter voltage as necessary to maintain the required generator alternating voltage under normal and fault conditions.

46-74—Application and Performance of Electronic Exciters for Large A-C Generators; *H. A. P. Langstaff* (*F '43*), *H. R. Vaughan* (*M '41*), *R. F. Lawrence* (*A '44*). *20 cents.* Power rectifiers have proved themselves as efficient and reliable convertors of a-c to d-c power for many industrial applications. They also have been used to a limited extent as exciters for synchronous motors and condensers. This paper discusses the requirements of rectifiers when used to excite large a-c generators and presents the results of tests made to determine performance under various operating conditions. The results cover preliminary tests that were made on a laboratory model in addition to extensive and more complete tests on an electronic exciter now installed in the Springdale generating station of the West Penn Power Company. The electronic exciter was designed to serve eventually as the main exciter for an 81,250-kva 3,600-rpm turbine generator just installed, but is now supplying excitation to a 47,100-kva 1,800-rpm turbine generator. Switching arrangements are provided for exciting either unit from the electronic exciter or from an existing motor-driven exciter.

46-75-ACO—Electronic Generator Voltage Regulator; *J. E. Reilly* (*A '41*), *C. E. Valentine* (*M '41*). *15 cents.* This paper describes the design and development of an electronic control network for use either with an electronic or a d-c rotating exciter. The new regulator employs the principle of balancing the regulated voltage against an electronic controlled reference voltage which is contained directly in the regulator circuit. A discussion of the method of stabilization and two types of polyphase response are included. An analysis of test results obtained from a test run with an electronic exciter used in conjunction with an a-c generator is described.

46-76-ACO—Excitation Systems for Turbine Generators; *M. D. Ross* (*M '42*). *15 cents.* The availability of the modern turbogenerator unit, together with its boiler and accessories, has been improved to a point where continuity of operation over long periods of time is the rule rather than the exception. The question of excitation supply in this connection is, therefore, one of prime importance. A review and comparison of present and proposed excitation schemes is given here, not with the idea of giving an exhaustive analysis but to place most of the facts about each in such form that they can be readily compared.

46-77—Motor-Driven Exciters for Turbine Alternators; *R. B. Bodine* (*M '45*), *S. B. Crary* (*F '45*), *A. W. Rankin* (*M '45*). *25 cents.* This paper presents a study of the performance of a motor-driven excitation set for large turbine alternators connected to modern power systems. This excitation set has been so designed that its performance, both steady state and transient, is essentially comparable with the usual direct-connected (shaft-driven) exciter even when the driving motor is receiving its voltage from the alternator to which the generator is supplying excita-

tion. Motor-driven exciters for turbine alternators have the following advantages over direct-driven exciters:

(*a*). Exciter set can be installed in less expensive locations.

(*b*). Exciter set can be designed easily for optimum d-c generator speed.

(*c*). The design and construction of the main alternator unit is simplified.

A discussion is given outlining the required performance characteristics and design principles of such a motor-driven exciter set. The conclusion is drawn from this study that a system using modern equipment and design practices readily can take advantage of the possibility of using motor-driven exciters of co-ordinated design.

46-78—Excitation Systems for Synchronous Machines; *S. B. Crary* (*F'45*), *J. B. McClure* (*A'29*). *15 cents.* This paper is written to assist in the formulation of synchronous machine excitation system standards on a functional basis. In this way the performance characteristics for any type of excitation system are given in terms of what experience and theory indicate as being necessary and desirable. This paper includes:

(*a*). A review of established and proposed definitions or terms.

(*b*). A statement of a suggested performance specification.

(*c*). A discussion of these requirements.

A discussion of such performance factors is particularly appropriate at this time because of the increasing attention being given to improved methods for automatic regulation. One of the important factors which has directed attention recently to the problems of automatic regulation of excitation has been the desirability of obtaining increased capacity in large 3,600-rpm turbine generator sets.

Power Transmission and Distribution

46-16—Lightning Performance of 220-Kv Transmission Lines—II, *an AIEE committee report. 15 cents.* The lightning performance of 220-kv transmission lines in the United States and Canada is presented and discussed. The paper gives the lightning outage record for the past 10 years of the lines of 13 companies who operate lines of this voltage. A number of features of electric design and mechanical construction are given and the significance of some of these factors discussed and evaluated. An analysis of the effect of insulation, ground wires, shielding angle, and tower footing resistances has been made in an attempt to show the significance or trends of line operation as affected by these different features. A comprehensive tabulation of pertinent data on these lines is given, which should be of interest and value to those now operating 220-kv systems or proposing to do so in the future.

Protective Devices

46-19—Field Tests of Interrupting Capacity of 138-Kv Oil Circuit Breakers; *W. B. Buchanan* (*M'32*), *G. D. Floyd* (*M'28*). *20 cents.* This paper describes staged tests made on 2 138-kv single-tank oil circuit breakers, in one case, up to 1,500,000 kva, and in the other, up to 2,500,000 kva. The connected generator capacity of the system is 1,750,000 kva. The purpose of the test was to determine the ability of the circuit breakers to interrupt currents equivalent to 1,500,000 kva and 2,500,000 kva on a 25-cycle system. The preliminary work associated with the test, the procedure during the test, and the condition of the circuit breaker contacts after interrupting the foregoing short circuits are described. Several photographs of the contact assemblies are included, as well as typical oscillograms. Comparison of actual current with that obtained from decrement curves is made for one test.

46-20—A New Line of High-Voltage Outdoor Tank-Type Oil Circuit Breakers; *W. F. Skeats* (*F'43*), *E. B. Rietz* (*A'42*). *25 cents.* Recent advancements in the design of interrupters operating mechanisms and bushings are co-ordinated in the design of a new line of outdoor oil circuit breakers, 115 kv to 230 kv inclusive. With past experience, performance, and tests as a basis it has been possible to introduce new features in the construction of this line of circuit breakers which result in marked improvements in performance characteristics. Among the most important of these features is a new interrupter. This interrupter is described, and its performance characteristics over a wide range of currents and voltages are presented. Its compact design permits a substantial reduction in circuit breaker tank sizes. Sealed bushings prevent contamination of the bushing oil and reduce maintenance. Advantage is taken of the operating characteristics of pneumatically trip-free mechanisms to provide very fast reclosing for either 5-cycle or 3-cycle circuit breakers. Other features also are described.

46-21—Dielectric Recovery by an A-C Arc in an Air Blast; *T. E. Browne, Jr.* (*M'45*). *30 cents.* Experimental results with models of air-blast interrupting nozzles like those used in high-voltage compressed air circuit breakers are presented. It is shown that the important region in such nozzles for the interruption of high currents coincides closely with the region of maximum flow constriction but that the interrupting region for smaller currents is not so sharply limited. Dielectric recovery with time is shown to proceed generally in three stages:

1. A finite delay period, dependent upon arc current and air pressure before appreciable dielectric recovery begins.

2. A period of rapid recovery at a rate roughly proportional to air pressure times velocity.

3. A plateau period of very slow subsequent recovery to the ultimate dielectric strength of the interrupting gap.

A brief discussion of the relation of these results to dielectric recovery theory is included.

46-22—Long 60-Cycle Arcs in Air; *A. P. Strom* (*M'39*). *20 cents.* Volt-ampere characteristics of 60-cycle arcs in still air with lengths and currents such as occur in power systems have been investigated under laboratory conditions. The arcs varied in peak current from 68 to 21,750 amperes and in length from 1/8 to 48 inches. Typical oscillograms and volt-ampere curves of these tests are presented. The voltage gradient in the arc is affected very little by current magnitude. Throughout the entire range all gradients remained between 21.5 and 50 volts per inch, with 35 per cent of all values in a 5 volt per inch interval having an average value of 34 volts per inch. The increase in apparent gradient due to voltage drop at the electrodes was found to be negligible where the arc length exceeds several feet. The decrease in short-circuit current of a power system through a series arc as compared with that for the same system with a metallic short circuit has been investigated. Data are presented showing the actual reductions observed for various conditions of circuit voltage and impedance.

46-35—Protection of Pilot Wires From Induced Potentials; *R. B. Killen* (*A'43*), *G. G. Law* (*A'44*). *15 cents.* Pilot-wire relays which transmit a single-phase alternating current over the pilot wires must be protected against incorrect tripping when induced potentials are being discharged. This often results from unsymmetrical operation of arresters used on pilot wires subject to induced potential. This paper describes a method of protection which provides reliable and satisfactory operation of pilot channels through low-voltage telephone-type cable, even though the cable may be subject to induced potentials high enough to operate discharge gaps. Data are included indicating the nature and magnitude of the potentials encountered on both overhead and underground pilot wires paralleling 12-kv 4-wire power circuits on the Dayton Power and Light Company system. Test data also are included on the zero-phase sequence impedance constants of a 1.87-mile underground cable circuit.

46-36—Linear Couplers Field Tests and Experience at York and Middletown, Pa.; *E. L. Harder* (*M'41*), *E. H. Klemmer* (*A'42*), *R. E. Neidig* (*A'38*). *20 cents.* Linear couplers, or air-core mutual reactors were applied for the protection of the 114-kv busses at York and Middletown, Pa., to provide instantaneous protection with a large factor of safety, using equipment of moderate size and weight. As this was the pioneer installation of this new protective system, a program of field tests was decided upon. Through- and internal-fault tests covering much wider

range of currents than will occur in service showed 100 per cent correct operation. Subsequent field experience of about two years confirms this operation. The couplers are of a special toroidal design, having coupling only to a conductor which actually links the toroid. They are mounted in the usual bushing current transformer compartments of the circuit breakers. The secondary windings are connected in a series loop, including the relay to form a differential protective circuit. The coupler theory is reviewed to aid in interpreting the several tests, and the field of application is discussed.

46-38—Application of the Ohm and MHO Principles to Protective Relays; *A. R. van C. Warrington* (*M '43*). *25 cents.* More accurate distance measurement is provided by distance relays with measuring units having polarizing windings. Current polarization produces a constant ohmic response at a particular angle, a well-known application being the reactance relay which ignores arc resistance and hence is indispensable for short lines and for protecting against ground faults. Potential polarization provides the inherent directional properties of the MHO unit, which not only reduce the number of relay units but also result in an impedance characteristic that fits closely around the fault area and hence makes the relay insensitive to any but fault conditions. The limitations of these units are discussed, and a number of applications to transmission line protection are described.

46-39—The MHO Distance Relay; *R. M. Hutchinson* (*A '41*). *20 cents.* The increase in loading of transmission lines and construction of longer lines in recent years has called for relays with more accurate phase angle discrimination to obtain the proper operation during power swings. The construction and operating characteristics of such a unit using a 4-pole induction cylinder operating element is described. The basic unit is inherently directional and provides accurate distance measurement. Three units provide 3-step distance protection between 2 phases with the aid of an auxiliary timing relay. The third zone unit makes use of a transactor to offset its characteristic in order to have strong torque after the initially strong transient torque has disappeared.

46-42—The Development, Design, and Performance of Magnetic-Type Power Circuit Breakers; *L. J. Linde* (*M '45*), *B. W. Wyman* (*A '40*). *20 cents.* Power circuit breaker interrupters can be divided into two basic types—those which maintain a low resistance arc until the final current zero where interruption is completed, and those which establish a high resistance arc prior to the final current zero. The magnetic air circuit breaker is the most outstanding example of the latter in which an arc resistance of sufficient magnitude may be introduced into the circuit to modify appreciably the circuit contacts before recovery voltage is established. This paper describes the manner in which this beneficial high arc resistance is obtained in the Magneblast line of power circuit breakers for 2,300- to 15,000-volt applications. Operating characteristics and design features of the line also are described.

46-43—Metal-Clad Unit Type Switchgear for 33-Kv Service; *C. H. Kreger* (*M '39*). *25 cents.* This discussion is a report of the successful operation of 33-kv metal-clad equipment by the Public Service Company of Northern Illinois during the past 17 years. The objectives and advantages sought when this equipment was first installed were: safety, reliability, economy. These terms are defined for the purpose of the discussion. The early difficulties are discussed in some detail in order to show that they were not fundamental faults and were overcome, resulting in equipment with a maximum degree of safety and reliability. A cost comparison is made with conventional open type construction to show that over-all economy was achieved when all factors are considered. Some thoughts are given for future design, and the main conclusion reached that, although development of this type of equipment for voltages above 12 kv has been allowed to lapse, it should be resumed, as it offers a fertile field for reduction of costs.

46-44—Arcing Ground Tests on a Normally Ungrounded 13-Kv 3-Phase Bus; *J. E. Allen* (*M '39*), *S. K. Waldorf* (*M '36*). *25 cents.* Theories have been published which show that arcing grounds of the restriking type can cause voltages to ground on an ungrounded system of the order of 6 to 8 times normal. The validity of these ideas has been investigated as they apply to an ungrounded 13-kv 60-cycle 3-phase bus system by making high voltage arcing ground tests on the actual bus system. It has been found that any arcing ground likely to occur in a natural way in normal operation is not likely to produce voltages to ground greater than two to three times normal. It is concluded that multiple insulation failures on ungrounded busses probably are not caused by very high voltage but by deteriorated bus insulation not being able to withstand three times normal phase-to-neutral voltage. The behavior and detection of ground faults on ungrounded busses are analyzed in an appendix.

46-45—New Series Capacitor Protective Device; *R. E. Marbury* (*F '45*), *J. B. Owen* (*A '45*). *15 cents.* A series capacitor is best protected from overvoltage during fault by a gap having low arc drop with no tendency to cutoff. In this manner the capacitor is not subjected to repetitive voltage peaks during fault, and high current oscillations in the circuit formed by the capacitor and gap are minimized. A special design of graphite gap with self-centering arc characteristics is described. A new type of by-pass switch also is described for automatically by-passing the gap and series capacitor and removing the by-pass after the fault has cleared. The switch shown provides an inherent time delay on closing, thus allowing time for the capacitor to discharge through the gap and avoid damage to the switch contacts. The switch also provides time delay on reopening, thus eliminating the necessity for a holding means which always has been a problem with magnetic contactors in this application. The motive power for closing the switch is derived from a sealed bellows using high resistance metal and containing a volatile liquid. The passage of current through the bellows changes the vapor pressure and furnishes the forces required to operate the switch. A device of this type is not subject to damage by steep wave front surges associated with the discharge of the capacitor through the protective gap, nor is it damaged by intermittent line faults. The combination of this gap and switch has many advantages over a conventional gap and magnetic contactor and should permit a more general application of series capacitors to distribution circuits.

46-55—Size Reduction and Rating Extension of Magnetic Air Circuit Breakers up to 500,000 Kva, 15 Kv; *R. C. Dickinson* (*M '41*), *Russell Frink* (*A '43*). *15 cents.* Self-contained air circuit breakers have been available since 1929, operating on the multiple cold-cathode principle in which the arc is divided into a multiplicity of arcs in series by metallic plates. These circuit breakers later were supplemented by circuit breakers operating on the principle of magnetic deionization of a single arc when it is moved into tapered slots in insulating plates. Fundamental research on the second mentioned principle has demonstrated that, by introducing a phase shift in the magnetic field acting on the arc, together with improvements in plate slot shape and general magnetic field strength, a remarkable gain in interrupting ability for a given size device is achieved. This knowledge has been used in developing a new line of magnetic air circuit breakers for ratings up to 500,000 kva and 15 kv. It has permitted the design of horizontal drawout air type metal-clad switchgear with smaller space requirements than heretofore possible.

SECTION • • • • •

Philadelphia Section Holds Meeting at Princeton

Looking toward the establishment of a Subsection in the Princeton–Trenton, N. J., area, the Philadelphia Section, AIEE, held a meeting at Princeton University November 20, 1945. The attendance of 215 included 34 AIEE members from the Princeton–Trenton area and from Philadelphia proper. Others present included members

of the Institute of Radio Engineers, engineers from the laboratories of Radio Corporation of America, and faculty members and students from Princeton University.

The speaker was Doctor Phillips Thomas (M '24) special representative of the Westinghouse Electric Corporation, East Pittsburgh, Pa. In "Adventures in Electricity" Doctor Thomas covered the chronology of high-speed communication from the time of Samuel Morse to the present. Each step in the development was treated as a piece in a jig-saw puzzle until the picture finally was completed. His other demonstrations included a light-beam relay, use of a vortex gun to generate air rings which blew out a candle flame at 15 feet, transmission of voice over a flashlight beam, and illustrations of the stroboscopic principle.

Advanced Lighting Course in New York. Under the auspices of the New York Sections of Illuminating Engineering Society and the AIEE, an advanced lighting course, entitled, "Applied Lighting," will be given from January 9 through March 13, 1946. In ten sessions on consecutive Wednesdays the course will outline how the fundamentals of lighting may be successfully applied in the field. Such subjects as, "Prescribed Illumination," "Industrial Lighting," and many other applications of lighting will be covered.

Technical Group Meeting in Springfield. The Springfield, Mass., Section, AIEE, held a meeting November 19, 1945, for the purpose of organizing a technical group on electronics. L. P. Kongsted (F '29) manager, engineering research, American Bosch Corporation, Springfield, is chairman of the technical group meetings.

Fourth Progress Report Submitted on AIEE Aeronautical Standards

Standardization work concerning aeronautical electric equipment, although curtailed in some of its phases because of the conclusion of the war and resultant reorganization problems, is being carried on by the AIEE and other interested organizations. The fourth progress report dated November 8, 1945, which follows the third report (*EE, Aug '45, p 303*), summarizes AIEE activities and gives information concerning some others.

AIEE AIR TRANSPORTATION COMMITTEE

This committee, under the chairmanship of J. D. Miner, Jr., (M '42) engineering manager, small motor division, Westinghouse Electric Corporation, Lima, Ohio, is progressing favorably with its various standardization assignments, in addition to sponsoring papers and reports on aircraft subjects. The work is now being carried on by five subcommittees . . . the joint subcommittee on carbon brushes recently having been organized. The status of these subcommittee projects may be summarized as follows:

Aircraft Electrical Systems Subcommittee

Under the chairmanship of R. H. Kaufmann (M '41) application Engineer, General Electric Company, Schenectady, N. Y., tentative drafts of certain sections of the report on "Aircraft Electrical Systems" were circulated to the subcommittee early in the fall but as there are many sections yet to be received it appears likely that it will be some time before the first draft of the proposed report will be completed. The conclusion of the war disrupted the schedule somewhat but a new operating schedule soon will be undertaken and it is anticipated that work will progress rapidly thereafter.

Aircraft Electric Rotating Machinery Subcommittee

A preliminary draft of a "Test Code for D-C Aircraft Motors" is about two thirds complete under the chairmanship of M. L. Schmidt (M '43). Individual reports now are being consolidated for distribution to subcommittee members in preparation for a meeting of the subcommittee in the near future.

Aircraft Electrical Control and Protective Devices Subcommittee

Under the chairmanship of R. A. Millermaster (M '34) supervising development engineer, Cutler-Hammer, Inc., Milwaukee, Wis., the most important assignment of this subcommittee, a "Test Code for Aircraft Protective Devices," is involved closely with the work of R. H. Kaufmann's subcommittee on aircraft electrical systems. As soon as the aircraft electrical systems report is made available, it is planned that this subcommittee will continue with consideration of the afore-mentioned assignment.

Aircraft Wire and Cable Subcommittee

In connection with the test code for evaluating aircraft wire and cables which this group is preparing under the chairmanship of W. S. Hay, the necessity of establishing the plastic flow of the insulation while under various conditions of heat and pressure is very evident. A program has been set up to determine this, and reports have been received from practically all members of the working group. It is hoped that this program can be completed shortly. Additional oscillograph studies of temperatures are being made, seeking to further corroborate the initial findings.

Carbon Brushes Subcommittee

This subcommittee under the chairmanship of V. P. Hessler is sponsored jointly by the air transportation and electric machinery committees. Its assignment includes the preparation of a test code for the evaluation of carbon brush performance on all types of commutators and slip rings, so as to provide for improved design and standards for carbon brushes used on electric machinery. The membership includes representation from carbon companies, aircraft manufacturers, and electric equipment manufacturers. The present program involves study of the United States Bureau of Ships specifications for carbon brushes and the preliminary recommendation by Messrs. Stauffer and Summers for an AIEE test code for carbon brushes.

It is expected that additional investigation work will be necessary before it will be possible finally to adopt a brush test code. The operating characteristics of small brushes differ quite materially from the larger brushes used on heavy power equipment. Standard high altitude conditions will have to be chosen to assure a uniformity of test for high altitude brush life.

NASC GENERAL OUTLINE FOR AIRCRAFT EQUIPMENT TESTING

The National Aircraft Standards Committee has recently published "General Outline for Aircraft Equipment Testing." This was developed by a special panel of the aircraft war production council under the chairmanship of H. W. Adams, Douglas Aircraft Company, and co-ordinated through the cognizant Society of Automotive Engineers' committees. It is primarily a statement of technical policy and is not intended to be mandatory. Copies may be obtained through the National Aircraft Standards Committee of the Aircraft Industries Association of America, Washington, D. C.

NASC—Standard Method of Electrical Load Analysis

Further progress under the chairmanship of K. R. Smythe (M '44) electrical engineer, Glenn L. Martin Company, Baltimore, Md., has been made in the preparation of a standard method for analyzing aircraft electrical loads for primary and secondary a-c systems. It includes a chart for recording electrical loads under various aircraft operating conditions to determine necessary generating capacity and to facilitate designs of circuits.

SAE AERONAUTICAL COMMITTEE A-2

Under the auspices of SAE aeronautical committee A-2, and under the chairmanship of C. C. Shangraw, Army-Navy aeronautical specification AN-M10a for aircraft d-c motors for 28-volt systems was co-ordinated with industry and issued in final form under date of August 1945.

Up to the present time only one Standard has been issued, namely, AIEE 700, entitled "Report on Aircraft D-C Apparatus Voltage Ratings."

PERSONAL.....

M. C. McKay (A '03, M '33) station construction engineer, Pacific Gas and Electric Company, San Francisco, Calif., has retired. Mr. McKay was born in 1880 in San Francisco. In 1898 he was employed by the Oakland (Calif.) Gas, Light, and Heat Company, predecessor of the Pacific Gas and Electric Company. Subsequently he became construction engineer for a number of hydroelectric projects in California. He also served as sales engineer of the Western Electric Company, San Francisco; general superintendent, American River Electric Company, Stockton, Calif.; resident engineer and construction superintendent on Stanislaus power-house construction in Tuolumne County, Calif., and general superintendent in charge of construction of the Sierra and San Francisco Power Company and Coast Valleys Gas and Electric Company systems. On leave from his company in 1914 Mr. McKay served as electrical assistant of the Panama–Pacific International Exposition, San Francisco. Subsequently, upon the leasing of the Sierra system to the Pacific Gas and Electric Company he was continued for a period as superintendent of the Sierra system, but later was appointed assistant engineer of general construction department, Pacific Gas and Electric Company.

G. M. L. Sommerman (A '31, M '37) formerly research engineer, electrical cable works, American Steel and Wire Company, Worcester, Mass., on leave to act as senior engineer, Office of Scientific Research and Development, and later of the United States Navy, Bureau of Ordnance, Silver Springs, Md., is now associate professor of electrical engineering, Northwestern University, Evanston, Ill. Doctor Sommerman, 1937 winner of the Alfred Noble prize, was graduated from Johns Hopkins University with a bachelor-of-engineering degree in 1929, and a doctor-of-engineering degree in 1933, both in electrical engineering. He had various assignments including one with the American Telephone and Telegraph Company, Baltimore, Md., before becoming in 1931 assistant physicist, research department, Consolidated Gas Electric Light and Power Company, Baltimore, Md. Three years later he was made research engineer, American Steel and Wire Company. He was a member of the AIEE committee on instruments and measurements, 1934–43, and the committee on research, 1936–39, 1944–45.

W. B. Morton (A '25, F '42) formerly senior field engineer, Philadelphia (Pa.) Electric Company, is now station electrical engineer, Pennsylvania Power and Light Company, Allentown, following his release from active duty as commander, United States Naval Reserve, in which he served as material superintendent, Navy Yard, Philadelphia. Mr. Morton was employed by Pacific Gas and Electric Company, San Francisco, Calif., in 1923, as draftsman and later as construction foreman in the station construction department. In 1925 he became electrical engineer for the Alabama Power Company, Birmingham, and in 1927 took charge of the electrical design division. He joined the staff of the Philadelphia Electric Company in 1931. He is past chairman and secretary, AIEE Philadelphia Section, and currently is a member of the AIEE board of directors. He has been a member of the following committees: Sections, 1940–44; membership, 1941–43; technical program, 1941–43; transfers, 1941–42, and land transportation, 1944–45.

G. H. Bragg (A '05, M '28) formerly engineer of maintenance, Pacific Gas and Electric Company, San Francisco, Calif., retired October 1, 1945. Mr. Bragg was born in San Francisco, and was graduated from the Leland Stanford University with a bachelor-of-arts degree. He has had an experience of 42 years with the Pacific Gas and Electric Company and its predecessors during which time he held various positions starting as a power-house operator and working up to construction workman, foreman, power-house superintendent, district manager, assistant to the chief engineer, and engineer of maintenance. He was a member of the AIEE protective devices committee, 1920 and 1924–25. **E. A. Crellin** (A '13, F '28) formerly assistant engineer of maintenance, becomes engineer of maintenance. Mr. Crellin was chairman of the AIEE San Francisco Section, 1930–32, and a member of AIEE power-generation committee, 1931–32; membership, 1937–38, and transfers, 1942–45.

L. W. Clark (A '25, M '42) formerly planning engineer, system engineering department, Detroit (Mich.) Edison Company, has been appointed assistant superintendent, underground lines department. Mr. Clark was graduated from the University of Wisconsin in 1923 with a bachelor-of-science degree in electrical engineering. Before entering the engineering department of the Detroit Edison Company in 1928 he had been associated with the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., and with the A. C. Nielsen Company, Chicago, Ill. **R. C. Bouse** (A '45) formerly engineer, planning division, has been made utilization-equipment and primary-supply engineer. Mr. Bouse received a bachelor-of-science degree in electrical engineering from the University of Idaho. Before becoming general test engineer of the Detroit Edison Company in 1928, Mr. Bouse was associated with the General Electric Company, Schenectady, N. Y.

J. N. Banky (A '44) electrical engineer, Allis-Chalmers Manufacturing Company, Milwaukee, Wis., has been awarded a $3,000 graduate fellowship for a year of study at the Illinois Institute of Technology, Chicago, from which he was graduated in 1943 with a bachelor-of-science degree.

M. R. Sullivan (M '42) formerly vice-president, operation and engineering department, American Telephone and Telegraph Company, New York, N. Y., has resigned to serve as president of the four Chesapeake and Potomac telephone companies which serve Maryland, District of Columbia, Virginia, and West Virginia. From 1912 to 1919 Mr. Sullivan filled various positions in the traffic department, Pacific Telephone and Telegraph Company, San Francisco, Calif. From 1934 to 1938 he had charge of all engineering and operation in the northern California–Nevada area, and from 1938 to 1941 in the states of California, Nevada, Oregon, and Washington. In 1941 he was made vice-president, American Telephone and Telegraph Company, in charge of the broader features of a wide range of electrical-engineering work relating to the engineering of the plants of the Bell Telephone System throughout the United States.

W. S. Edsall (M '19) formerly manager, switchgear and control division, electrical department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis., has been appointed vice-president and general manager of the Chase-Shawmut Company, Newburyport, Mass. Mr. Edsall was graduated from the University of Montana with the degree of electrical engineer and from the school of commerce, accounts and finance, New York University. He served in the United States Navy submarine service in World War I. Prior to his connection with the Allis-Chalmers Company he was associated with the American Brown-Boveri Electric Corporation, and also served the Westinghouse Electric and Manufacturing Company and the Sperry Gyroscope Company, Brooklyn, N. Y. Mr. Edsall has been active in the National Electrical Manufacturers Association. He has served on the AIEE protective devices committee.

H. N. Blackmon (M '32) formerly manager, editorial service, public relations department, Westinghouse Electric Corporation, Pittsburgh, Pa., is now electrical editor of *Product Engineering*, a McGraw-Hill publication with offices in New York, N. Y. Mr. Blackmon had been associated with the Westinghouse company since his graduation from Georgia School of Technology in 1925 as electrical engineer. Following service as an engineer in the switchboard-engineering department and in the general-engineering department, in 1932 he was named technical editor of the company's technical press bureau and since 1938 he has been manager of the editorial service.

J. D. Cobine (A '35, M '41) formerly assistant professor of electrical engineering, Harvard University, Cambridge, Mass., is now research physicist, research laboratory, General Electric Company, Schenectady, N. Y. Doctor Cobine was counselor AIEE, Harvard University Branch, 1935–45.

J. W. Barker (M '26, F '30) dean, faculty of engineering and professor of electrical engineering, Columbia University, New York, N. Y., has returned to Columbia from a leave to serve as special assistant to the Secretary of the United States Navy. Doctor Barker is also acting president of Research Corporation, New York. From 1916 to 1925 he was with the Coast Artillery Corps, United States Army, and in the latter year became associate professor of electrical engineering at the Massachusetts Institute of Technology, Cambridge. In 1929 he was appointed professor of electrical engineering and made head of the department of electrical engineering and director of the curriculum in electrical engineering, Lehigh University, Bethlehem, Pa. In 1930 he went to Columbia University as professor and dean of faculty of engineering. Doctor Barker was AIEE vice-president, 1940–42.

C. L. Emerson (M '20, F '33) vice-president and chief engineer, Robert and Company, Inc., Atlanta, Ga., has been appointed dean of engineering, Georgia School of Technology, Atlanta. Mr. Emerson is a graduate of the Georgia School of Technology with the degree of bachelor of science in mechanical engineering and in electrical engineering. From 1909 to 1915 he was associated with the Westinghouse Electric and Manufacturing Company in East Pittsburgh, Pa., Boston, Mass., Philadelphia, Pa., and Charlotte, N. C. Later he became assistant engineer for the mill-power department of the Southern Power Company, Charlotte, and then assistant to the chief engineer. In 1919 he accepted the position as power engineer with Robert and Company and has been in charge of design and installation of industrial electrical equipment also steam plants and hydroelectric plants for textile mills.

G. G. Landis (M '35, F '40) chief engineer, Lincoln Electric Company, Cleveland, Ohio, has been named vice-president in charge of engineering. Mr. Landis received his electrical engineering education at Ohio State University, being graduated with a bachelor-of-science degree in 1922. For a short period he was associated with the General Electric Company at Fort Wayne, Ind., and with the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. In 1923 he became development engineer of the Lincoln Electric Company. Subsequently he was appointed design engineer and in 1930 chief engineer. Mr. Landis is a director of the company, and has charge of the design and production engineering on welding equipment manufactured by the company. He has contributed numerous articles to the trade magazines.

E. W. Kimbark (A '27, M '35) formerly associate professor of electrical engineering, Northwestern University, Evanston, Ill., has been advanced to professor of electrical engineering. Professor Kimbark is a native of Chicago, Ill., and received the degrees of bachelor of science (1924) and electrical engineer (1925) from Northwestern University, and a master of science in electrical engineering (1933) from Massachusetts Institute of Technology. For a time as assistant professor of electrical engineering he was at Brooklyn (N. Y.) Polytechnic Institute prior to becoming a member of the faculty at Northwestern University in 1940.

C. G. Brennecke (A '39) associate professor of electrical engineering, Lehigh University, Bethlehem, Pa., has been appointed head of the department of electrical engineering, North Carolina State College of Agriculture and Engineering, Raleigh. He was graduated from Columbia University as a bachelor of arts, bachelor of science, and electrical engineer, and received a doctor-of-philosophy degree from New York University. Following experience with the Radio Corporation of America, New York, N. Y., he went to New York (N. Y.) University, and then to University of Toledo, Toledo, Ohio, where he became subsequently assistant professor of electrical engineering and secretary of engineering college. He went to Lehigh in 1943.

H. C. Dean (A '12, F '30) executive vice-president, New York and Queens Electric Light and Power Company, New York, N. Y., was elected a vice-president of the Consolidated Edison Company of New York, Inc., following the recent merger of the New York and Queens Electric Light and Power Company with the Brooklyn Edison Company into the Consolidated Edison Company. Mr. Dean was graduated from the University of Illinois in 1909 with a degree of bachelor of science in railway electrical engineering. Before his association with the New York and Queens property which began in 1916 when he was appointed assistant to the vice-president and general manager, he was electrical engineer in charge, bureau of engineering and construction, department of gas and electricity, City of Chicago, Ill.

J. J. Little (A '22, M '34) general manager, Northern British Columbia Power Company, Prince Rupert, British Columbia, Canada, now holds the additional position of vice-president. Mr. Little was born in Edinburgh, Scotland, and at the completion of his education he was apprenticed to McEwen Clarke and Company, an electrical engineering firm in Edinburgh, and later, still in that country, was employed in general electrical work for the Tanfield Shipbuilding Company. In 1912 he became electrician, City of Prince Rupert, subsequently being appointed assistant superintendent and then superintendent. In 1929 the municipal system was purchased by the Power Corporation of Canada, and when the local company was formed under the name of Northern British Columbia Power Company Mr. Little was appointed general manager.

Bern Dibner (A '23, F '42) recently lieutenant colonel, Army of the United States, and formerly vice-president, Burndy Engineering Company, Inc., New York, N. Y., has returned to his civilian position as head of the company he founded in 1924 for the manufacture of electrical connectors. He took leave from the Burndy company in 1942 and as captain was assigned to the Army Air Forces Proving Ground Command and later to the Strategic Bombing Survey in Europe. He was promoted to the rank of major in 1943 and then to the rank of lieutenant colonel in 1945. He was awarded the Bronze Star Medal.

G. I. Page (A '34, F '45) formerly operating engineer, engineering and operating department, Public Service Company of Oklahoma, Lawton, has been promoted to the position of superintendent of operations and construction for the eastern and southwestern divisions. Mr. Page, a native of Iowa, was graduated from Iowa State College in 1925 with a bachelor-of-science degree in mechanical engineering. Subsequently, he was employed by Iowa Power and Light Company, Des Moines, Public Service Company of Oklahoma, Tulsa, and Southwestern Light and Power Company, Lawton. In 1944 he was appointed chief operating engineer for the southwestern division of the Public Service Company of Oklahoma.

M. C. Yatskin (A '36) formerly with Marsman Hong Kong China Ltd., Hong Kong, China, is now serving with the works branch, civil administration service, Hong Kong Military Government on the reconstruction and rehabilitation of the Hong Kong territory. Being a member of Hong Kong Volunteer Defense Corps he was mobilized in 1941. Subsequently he took part in the demolition of bridges and tunnels on the Kowloon-Canton Railway, British section, and later saw action on the Island of Victoria (Hong Kong). Following the capitulation of Hong Kong on Christmas Day 1941, Mr. Yatsin became a prisoner of war in Shamshuipo Camp, Kowloon. After liberation by Allied forces August 30, 1945, he was requisitioned to serve the Hong Kong Military Government. Mr. Yatskin, a native of Russia, is a graduate of Hong Kong University (1936) with the degree of bachelor of science in electrical engineering.

R. E. Kimball (A '40) major, United States Army Signal Corps, and division chief in the office of the chief signal officer at the headquarters of General Douglas MacArthur in Manila, P. I., has been promoted to the rank of lieutenant colonel. His

civilian career was with the General Electric Company at Philadelphia, Pa., and Schenectady, N. Y., where he served in the industrial control engineering department until 1941 when he was called to active military duty. In 1942 Colonel Kimball accepted a commission in the Regular Army.

W. F. Hess (A '32, M '41) professor of metallurgical engineering, and head of the welding laboratory, Rensselaer Polytechnic Institute, Troy, N. Y., has been elected president of the American Welding Society for the year 1945–46. Doctor Hess was graduated from Rensselaer Polytechnic Institute in 1925 with a degree in electrical engineering, and in 1928 received the degree of doctor of engineering. Beginning with 1928 at the Rensselaer Polytechnic Institute he was instructor and then assistant professor in electrical engineering and physics, and assistant professor and associate professor in metallurgical engineering. In 1945 he was raised to a full professorship.

G. B. Hoadley (A '35, M '41) formerly assistant professor, graduate electrical engineering department, Polytechnic Institute of Brooklyn, Brooklyn, N. Y., is now associate professor of electrical engineering. Doctor Hoadley went to Brooklyn in 1940 from Massachusetts Institute of Technology, Cambridge, where he had been instructor in electrical engineering. **W. R. MacLean** (M '44) formerly research associate, is now assistant professor of electrical engineering. **A. B. Giordano** (A '40) formerly instructor of electrical engineering, is now assistant professor of electrical engineering.

S. W. Zimmerman (A '32, M '40) formerly research engineer, lightning arrester department, General Electric Company, Pittsfield, Mass., is now associate professor, school of electrical engineering, Cornell University, Ithaca, N. Y. Mr. Zimmerman received from the University of Michigan bachelor-of-science and a master-of-science degrees in electrical engineering in 1930. Since that year he has been with the General Electric Company. Mr. Zimmerman has been active on many committees of the AIEE Pittsfield Section.

F. M. Tait (A '94, F '12) president and general manager, Dayton (Ohio) Power and Light Company, has received the honorary degree of doctor of engineering from Lehigh University. He is a past president of the Ohio Electric Light Association.

E. G. Schlup (A '27, M '38) since 1929 electrical engineer, American Rolling Mill Company, Middletown, Ohio is serving now as chief electrical engineer, general engineering department. Mr. Schlup was born in Berne, Switzerland, and received his education at State College, Zurich, Switzerland. He worked for the Bernise Power Works, Berne, and in the United States first was employed by the New York (N. Y.) Edison Company. Later he served the United Gas Improvement Contracting Company, Philadelphia, Pa.

G. W. Scott (M '45) assistant chief physicist, Armstrong Cork Company, Lancaster, Pa., recently was awarded a prize by the American Welding Society for a paper entitled, "Radiography for Development and Control of Aluminum Alloy Spot Welding."

D. E. B. Corson (A '33, M '41) formerly application engineer, power-factor division, Cornell-Dubilier Electric Corporation, South Plainfield, N. J., has resigned to establish a consulting-engineering practice in the field of capacitor application with offices in Rochester, N. H. Mr. Corson was graduated from the Massachusetts Institute of Technology in 1932 with a bachelor-of-science degree in electrical engineering.

J. L. Bower (M '45) formerly design engineer, aero and marine engineering division, General Electric Company, Schenectady, N. Y., is now chief development engineer, Control Instrument Company, Brooklyn, N. Y. Mr. Bower was graduated from the United States Military Academy in 1936 with the degree of bachelor of science later spending three years in the advanced course of the General Electric Company.

Fred Knaus (A '26, M '38) formerly industrial sales engineer, lighting department, City of Seattle, Wash., retired recently. He was born in Portland, Oreg., October 7, 1885. He was employed in the lighting department, City of Seattle, from 1910 until 1917 when he accepted a commission in the Field Artillery, United States Army. He returned to the lighting department in 1920 as senior contract agent.

J. L. Defandorf (M '45) formerly supervising engineer, Cutler-Hammer, Inc., Milwaukee, Wis., recently was appointed general engineering supervisor of equipment divisions. Since 1917 he has been continuously in the employ of Cutler-Hammer, Inc., and in 1927 was made a supervising engineer of control equipment. Several patents have been issued to him on electric controllers.

N. J. Conrad (A '07, F '21) retired since 1931 as secretary, treasurer, and general manager, Schweitzer and Conrad, Chicago, Ill., has resumed active management of the firm as president. Mr. Conrad is a graduate of the University of Wisconsin with the degree of bachelor of science in electrical engineering. He was cofounder in 1910 of the company known as Schweitzer and Conrad, Inc. In 1917 he was its general manager. During World War II Mr. Conrad served as Chicago district manager of the War Production Board and as an industrial panel member, War Labor Board.

L. T. Rosenberg (A '30, M '36) electrical machine designer, Allis-Chalmers Manufacturing Company, Milwaukee, Wis., has been elected treasurer of the Engineers' Society of Milwaukee of which he was a director from 1940 to 1943. Mr. Rosenberg was graduated from the University of Michigan with a bachelor-of-science degree in electrical engineering in 1926. He was secretary, Milwaukee Section, AIEE, 1935–36 and chairman, 1939–40; he also served on the membership committee, 1940–42.

L. D. T. Berg (A '45) formerly sales engineer, electric welding division, General Electric Company, Schenectady, N. Y., has been appointed welding specialist of the company's Atlantic district with headquarters in Philadelphia, Pa. He is a member of the American Welding Society.

W. R. Silvey (A '37) formerly transmission engineer, New York (N. Y.) Telephone Company, and more recently colonel of the Army of the United States has been awarded the Bronze Star Medal for meritorious service in military operations against the enemy in France, Belgium, and Germany.

G. Ross Henninger (F '43) was promoted from lieutenant colonel to colonel while on terminal leave from the Army Air Forces. He recently returned to his duties as AIEE editor (*EE, Dec '45, p 456*) after more than three years in military service.

L. W. Chubb (A '09, F '21) director of research, research laboratories, Westinghouse Electric Corporation, East Pittsburgh, Pa., has been elected a director of the Engineering Foundation, New York, N. Y.

OBITUARY.....

Louis Maxwell Potts (A '02, M '26) research engineer, Teletype Corporation, Chicago, Ill., died October 23, 1945. Doctor Potts was born in Canonsburg, Pa., October 30, 1876, and was graduated from Washington and Jefferson College in 1896 with the degree of bachelor of arts and from Johns Hopkins University in 1900 with a doctor-of-philosophy degree in physics. Before embarking on his professional career he taught physics and chemistry in the Washington (Pa.) High School, and was student assistant in physics at Johns Hopkins University, Baltimore, Md. In 1900 he became associated with the Rowland Telegraphic Company, Baltimore, first as electrical engineer and then as constructing engineer and chief engineer. In 1910 he became chief engineer of the Universal Telegraphic Company, and five years later chief engineer of the Universal Machine Company. From 1920 to 1925 he served as engineer of the Western Electric Company and in the latter year was named engineer of the Bell Telephone Laboratories,

New York, N. Y. During the years 1902 to 1910 Doctor Potts had entire charge of the electrical and mechanical design and construction of the Rowland multiplex printing telegraph. Machines were designed and built by Doctor Potts which were used by the Postal Telegraphic Company. In all, 37 patents have been granted to him on printing telegraph and other subjects. In 1928 Doctor Potts became research engineer of the Morkrum-Kleinschmidt Company, Chicago, Ill., and the successor, Teletype Corporation. He has been a fellow of the American Association for the Advancement of Science, Fellow, American Physical Society, and member, Societe Français de Physique. For AIEE he was secretary, Baltimore Section, 1909–20, and member of the telegraphy and telephony committee, 1920.

Walter Stuart Kelly (M '04) consulting engineer, Brookline, Mass., died July 4, 1945. Mr. Kelly was born November 9, 1857, in New Hampshire. He was graduated from the Chandler Scientific School of Dartmouth College with a bachelor-of-science degree in 1882. He engaged first in mill engineering, spending four years with Lawrence Manufacturing Company, Lowell, Mass. In 1888 he became consulting engineer for the Boston, Mass., office of the Sprague Electric Railway and Motor Company and from 1889 to 1891 he worked in New York, N. Y., as assistant to the chief engineer of the Sprague Electric Railway and Motor Company and upon the absorption of the Sprague property by the Edison General Electric Company he became designing engineer on special applications of electric motors. From 1891 to 1898 Mr. Kelly was associated with the Boston office of the motor department and later with the power and mining departments of the General Electric Company serving as engineer salesman. For the next five years he was electrical engineer with the Narragansett Electric Lighting Company, Providence, R. I. For the past several years Mr. Kelly was engaged in consulting engineering practice.

Carlton F. Blickley (M '44) regional construction engineer, design and construction division, Rural Electrification Administration, United States Department of Agriculture, St. Louis, Mo., died November 11, 1945. Mr. Blickley was born in Grand Rapids, Mich., October 25, 1900, and was graduated from the University of Cincinnati in June 1927 with the degree of civil engineer. Before graduation he had served as office and survey engineer for the city engineer of Grand Rapids, and as student engineer for various consulting engineers and contractors. Immediately after graduation he became associated with Pollak Steel Company, Cincinnati, Ohio, as design engineer, and remained there until October 1933. He next served the United Light and Power Engineering Construction Company, Davenport, Iowa, as appraisal engineer, and in 1935 became office and resident engineer for the Zanesville (Ohio) District Engineers, United States Engineer Corps. After short periods with the Southern Michigan Engineer Corporation, Lansing, Mich., and various rural distribution co-operatives, in 1938 he became field construction engineer of the Rural Electrification Administration, St. Louis, and in May 1940 was made regional construction engineer, design and construction division. Later he was made acting head, buildings and structures section. This latter employment was simultaneous with and in addition to regular employment as regional construction engineer and was filled in order to assist in the effort of World War II.

Alan Estis Flowers (A '04, M '13) engineer in charge of development, The DeLaval Separator Company, Poughkeepsie, N. Y., died in December 1945. Mr. Flowers was born in St. Louis, Mo., October 4, 1876. He took the electrical engineering course at Cornell University receiving two degrees from that university, one in mechanical engineering upon graduation in 1902, and a doctor-of-philosophy degree in 1915. Doctor Flowers was employed early in his career by the Westinghouse Electric and Manufacturing Company, and from 1904 until 1912 was on the staff of the University of Missouri, Columbia, as instructor, assistant professor, and associate professor of electrical engineering. In 1912 he became professor of electrical engineering at Ohio State University, Columbus. Later he was associated with the Columbus (Ohio) Railway, Power and Light Company, National Aniline and Chemical Company, New York, N. Y., and Chemical Machinery Construction Company. In 1923 he went to the DeLaval Separator Company. During World War I Doctor Flowers was a captain, Signal Corps, Army of the United States. He was the author of many technical papers, and was a member of several technical societies.

Charles Albert Perkins (A '05, M '05, F '40) professor emeritus of electrical engineering, University of Tennessee, Knoxville, died November 26, 1945. Doctor Perkins was born in Ware, Mass., October 31, 1858, and received from Williams College in 1879 a bachelor-of-arts degree, and from Johns Hopkins University a doctor-of-philosophy degree in 1884. He was professor of mathematics at Lawrence College, Appleton, Wis., from 1880 to 1881 and from 1884 to 1887 an assistant in physics at Johns Hopkins University, Baltimore, Md. In the latter year he was appointed associate in physics at Bryn Mawr (Pa.) College. From 1891 to 1892 he held the position of professor of physics and chemistry at the Hampden-Sidney (Va.) College. Doctor Perkins in the latter year went to the University of Tennessee and carried on the work of instruction as professor of physics and electrical engineering. He continued as head of the department until 1929. In 1921 he organized the engineering experiment station and became its director. In 1941 when he became professor emeritus of electrical engineering he became also consultant of the engineering experiment station. Doctor Perkins is the author of "Electricity and Magnetism," and several papers including a description of a slip indicator, used in testing induction motors.

Lee Clyde Ilsley (A '14) retired supervising engineer, electrical-mechanical section, United States Bureau of Mines, Pittsburgh, Pa., died November 23, 1945. Mr. Ilsley was born February 20, 1880, in Thetford, Vt., and was graduated from Worcester Polytechnic Institute in 1903 with a degree of bachelor of science in electrical engineering and of electrical engineer in 1905. His first year of employment was spent with the American Telephone and Telegraph Company in general telephone construction work. From 1905 to 1906 he was in the testing department of the General Electric Company, and for the next four years was engaged in the electrical department of the Delaware, Lackawanna and Western Railroad, Scranton, Pa. The year 1910 started his association with United States Bureau of Mines, where he was active in mine electrical safety work. He was put in charge of that work in 1918. He retired early in 1945. Mr. Ilsley took an active part in AIEE affairs and had served on many of its committees. These included mines and applications to mining work of which he was chairman from 1934–36; safety codes; Standards; technical program and industrial power applications.

Leonard Hathaway Brubaker (A '42) electrician, United States Navy Yard, Charleston, S. C., died September 30, 1945. Mr. Brubaker was born in Walla Walla, Wash., December 20, 1905, and was graduated from Kansas State College with a bachelor-of-science degree in electrical engineering in 1929, and from the University of Michigan with a master-of-science degree in electrical engineering in 1932. Prior to graduation he was student engineer with Curtis Lighting, Inc., Chicago, Ill., and illuminating engineer with the United Power and Light Corporation of Kansas, Abilene. From 1933 to 1935 he was instructor in physics and mathematics at the Gordon Military College, Barnesville, Ga., and for the next two years an instructor in science at the Lanier High School for Boys, Macon, Ga. After a year's service with the Georgia Power Company in Columbus and Augusta, in 1938 Mr. Brubaker became United States engineer, Clarks-Hill Hydro-Electric project, Augusta. In 1939 he became associated with the United States Navy Yard in Charleston and served in various positions.

Ralph Dietz Blumberg (M '44) consulting electrical engineer, R. D. Blumberg Company, Houston, Tex., died October 30,

1945. Mr. Blumberg was born in Seguin, Tex., February 18, 1898, and was graduated from the Texas Agricultural and Mechanical College in 1920 with a bachelor-of-science degree in electrical engineering. Following his graduation he was appointed instructor in the electrical engineering department of his college, College Station. After a year of teaching he became chief engineer and secretary-treasurer of three small power companies in Texas. In 1923 he took the position of electrical engineer of the Texas Power and Light Company, Dallas, and until 1940 served in various capacities, such as district construction engineer, district superintendent, and mostly as division district engineer and supervisor covering south, central and west Texas. From 1940 he had been electrical and consulting engineer in charge of electrical design and installations for several engineering firms under Government contract to build defense plants. These major projects and his positions in the order of their recency follow: electrical engineer, Gasoline Plant Construction Corporation, Houston, Tex.; project manager, Fisk Electric Company, Houston; electrical engineer, Lockwood and Andrews, engineers, Houston, and electrical engineer, Freese and Nichols engineers, Fort Worth, Tex.

Frank Cecil Angle (A '38) manager, field sales offices, general machinery division, Allis-Chalmers Manufacturing Company, Milwaukee, Wis., died October 25, 1945. Mr. Angle was born in The Dalles, Oreg., and was graduated from Oregon State College with a bachelor-of-science degree in 1923. After six years with the Elliott Company, Ridgway, Pa., as salesman, in 1929 Mr. Angle went to the Allis-Chalmers Manufacturing Company. In 1935 he became manager of the San Francisco, Calif., office, and in 1943 he was appointed manager of the Pacific region. In 1944 he was appointed manager of all field sales offices of the general machinery division. Mr. Angle was a member of the American Society of Mechanical Engineers.

David White McElroy (A '19) formerly chief engineer, New York sales department, General Electric International Company, New York, N. Y., died December 13, 1945. He was born in Keokuk, Iowa, June 5, 1888, and was graduated from Iowa State College with a bachelor-of-science degree in electrical engineering in 1910. He first became identified with the General Electric Company, Schenectady, N. Y., in 1910. Later he went to Havana, Cuba, for the International General Electric Company, and in 1934 was transferred to New York. He served in the World War I as an ensign in the United States Navy.

Walter Kremer Rhodes (A '09, M '26) professor emeritus of electrical engineering, Bucknell University, Lewisburg, Pa., died December 12, 1945. He was born near Fairfield, Pa., October 2, 1874, and was graduated from Bucknell University with a bachelor-of-philosophy degree in 1903, and from the University of Michigan with a bachelor-of-science degree in electrical engineering in 1908. Early in his career he was in the employ of Pennsylvania Railroad at Chester, Pa., doing general construction work, and of the Westinghouse Electric and Manufacturing Company. In 1907 he became professor of electrical engineering, Bucknell University. He was made professor emeritus in 1942.

George James Keys Patton (A '39) senior staff engineer, Bell Telephone Company of Pennsylvania, Philadelphia, died August 17, 1945. He was born July 24, 1886, and attended Drexel Institute. Mr. Patton was first employed by the Keystone Telephone Company, Philadelphia, and later served as district manager of the Atlantic County for the Eastern Telephone Company. In 1914 he transferred to the Bell Telephone Company where he was first apprentice installer, installation foreman, and in 1922 engineering assistant. In 1930 he was made senior staff engineer.

MEMBERSHIP...

Recommended for Transfer

The board of examiners, at its meeting of December 13, 1945, recommended the following members for transfer to the grade of membership indicated. Any objections to these transfers should be filed at once with the secretary of the Institute.

To Grade of Fellow

Green, E. I., test engr., Bell Telephone Labs. Inc., New York, N. Y.

1 to grade of Fellow

To Grade of Member

Barcus, G. L., application engr., General Electric Co., Philadelphia, Pa.
Blomquist, H. R., supervisor of engg. and research, United Electric Railways Co., Providence, R. I.
Broadbent, W. W., supt., New England Power Assoc., Narragansett Electric Co., Providence, R. I.
Brown, A. S., assoc. prof., elec. engg. dept., University of Arkansas, Fayetteville, Ark.
Buchta, M. A., requisition engr., General Electric Co., Philadelphia, Pa.
Chin, P., chief electronics design engr., York Research Corp., New York, N. Y.
Crawford, D. M., secretary, J. G. White Engg. Corp., New York, N. Y.
Ganz, A. G., member of tech. staff, Bell Telephone Labs., Murray Hill, N. J.
Gould, G. G., Lieut., USNR, Naval Ordnance Lab., Navy Yard, Washington, D. C.
Howard, S. B., proposition engr., General Electric Co., Pittsfield, Mass.
Ingram, M., chief engr., Pilot Marine Corp., New York, N. Y.
Johansen, H. C., instructor and research asst., school of elec. engg., Purdue University, Lafayette, Ind.
Kuhne, L. J., asst. dept. supt., Tennessee Eastman Corp., Oak Ridge, Tenn.
Linkletter, R. L., assoc. elec. engr., Puget Sound Navy Yard, Bremerton, Wash.
Morgan, G. W., design elec. engr., Gulf States Utilities Co., Beaumont, Texas.
Plautz, A. C., research staff, Douglas Aircraft Co., Santa Monica, Calif.
Sawyer, O. E., asst. district engr., Narragansett Electric Co., Providence, R. I.
Second, R. E., supt. of distribution, Narragansett Electric Co., Providence, R. I.
Seeger, F. H., chief operator, Shasta Power Plant, U. S. Bureau of Reclamation, Redding, Calif.
Shoch, W. N., engr., Philadelphia Electric Co., Philadelphia, Pa.
Stark, C. H., partner, Stark Electric Co., Baltimore, Md.
Warren, W. J., prof. elec. engg., University of Santa Clara, Santa Clara, Calif.
Wolf, E. M., elec. engr., Rome Cable Corp., Rome, N. Y.
Wood, C. O., elec. engr., Goodman Manufacturing Co., Chicago, Ill.
Wood, J. A., Jr., asst. prof. elec. engg., Massachusetts Inst. of Technology, Cambridge, Mass.
Zimmermann, H. J., asst. director, radar school, Massachusetts Inst. of Technology, Boston, Mass.

26 to grade of Member

Applications for Election

Applications have been received at headquarters from the following candidates for election to membership in the Institute. Any member objecting to the election of any of these candidates should so inform the secretary before February 15, 1946, or April 15, 1946, if the applicant resides outside of the United States or Canada.

To Grade of Member

Abel, N. E., I. B. Abel & Son, York, Pa.
Alexo, A., Bendix Aviation, Teterboro, N. J.
Altfather, C. T. (Re-election), Westinghouse Elec. Corp., Newark, N. J.
Andrews, P. D., General Electric Co., Schenectady, N. Y.
Boadway, C. W. (Re-election), The Hydro-Electric Power Comm. of Ont., Toronto, Ont., Can.
Burroughs, N. B., General Electric Co., Erie, Pa.
Carlisle, G. L. (Re-election), Railway & Industrial Engineering Co., Greensburg, Pa.
Clemence, L. G., Consumers Power Co., Flint, Mich.
Cox, H. B., Commonwealth & Southern Corp., Birmingham, Ala.
Dolkart, L. (Re-election), Cementos Portland del Bajio, Leon, Gto., Mex.
Garlock, R. G., Underwriters' Labs., Inc., Chicago, Ill.
Graff, J. W., Alabama Power Co., Birmingham, Ala.
Greer, R. C. L. (Re-election), New Hampshire Gas and Electric Co., Portsmouth, N. H.
Guess, L. T., Aluminum Co. of America, Newark, Ohio
Hansen, R. E., Leeds & Northrup Co., Houston, Tex.
Hanson, G. N., Sperry Gyroscope Co., Inc., Great Neck, N. Y.
Howard, G. A. (Re-election), Consumers Power Co., Jackson, Mich.
Kemp., L. D., McColl Elec. Works Pty. Ltd., Victoria, Aust.
Krause, C. G., City Public Service Board, San Antonio, Tex .
Lansch, J., Ebasco Services, Inc., New York, N. Y.
Lewis, W. F., Willey-Wray Elec. Co., Cincinnati, Ohio
Lincoln, G. R., The Ringmer & District Electricity Co., Ltd., Lewes, Sussex, England
Lipton, M. A., Coles Signal Lab., Fort Monmouth, N. J.
Logie, L. C., Tennessee Valley Authority, Knoxville, Tenn.
Lorenz, A. M. (Re-election), Public Lighting Commission, Detroit, Mich.
Lubke, P. N., Ford Bacon & Davis, Inc., Charleston, W. Va.
Mackley, J., c/o The High Commissioner for India, Aldwych, London, England
McConaghy, L. B., 512 Bendermere Ave., Interlaken, N. J.
Oakes, D., Leland Electric Canada, Ltd., Guelph, Ont., Can.
Osterle, W. H. (Re-election), West Penn Power Co., Pittsburgh, Pa.
Peters, C. E., Benwood Linze Co., St. Louis, Mo.
Philbeck, R. E., Tennessee Eastman Corp., Kingsport, Tenn.
Pittaway, A. H., Ohio Crankshaft Co., Cleveland, Ohio
Plass, C. E., American Steel & Wire Co., Chicago, Ill.
Pratt, R. H. (Re-election), R. H. Pratt Co., New York, N. Y.
Price, B. E., National Electric Coil Co., Philadelphia, Pa.
Price, L. D. (Re-election), National Electric Manufacturer's Association, New York, N. Y.
Ramsey, J. R. (Re-election), Kenneth A. McIntyre Assoc., Cleveland, Ohio
Rankin, C. J., Robert A. Rankin & Co., Montreal, Que., Can.
Rettger, W. V., Ambos-Jones Co., Cleveland, Ohio
Reynolds, L. J., Reynolds Electrical & Engg. Co., El Paso, Tex.
Richman, A. A., Lightning Electric Service Co., Newark, N. J.
Schlegelmilch, R. O., ATSC, Watson Laboratories, Red Bank, N. J.
Smith, C. S., Jr., 168 South Valley Road, West Orange, N. J.
Stout, C. R., Pure Oil Company, Nederland, Tex.
Thiel, E. A. (Re-election), Swift & Co., Chicago, Ill.
Tolman, C. P. (Re-election), 82-04 Austin St., Kew Gardens, N. Y.
Watson, J. D., Fischbach & Moore of Texas, Inc., Houston, Tex.
Westervelt, C. S. (Re-election), United Engineers & Constructors, Inc., Philadelphia, Pa
Williams, C. H. (Re-election), Robt. M. Dunville & Bros., Richmond, Va.
Windley, J. K., Lake Washington Shipyards, Houghton, Wash.
Wray, R. M., Willey-Wray Elec. Co., Cincinnati, Ohio

Wright, F. C., American Tel. & Tel. Co., Chicago, Ill.
53 to grade of Member

To Grade of Associate

United States and Canada

1. North Eastern

Bright, C. H., II, Manning, Maxwell & Moore, Inc., Boston, Mass.
Broussard, J. J., General Electric Co., Schenectady, N. Y.
Camp, P. L., General Electric Co., Boston, Mass.
Fitzgibbons, J. J., 32 Lake St., Pulaski, N. Y.
Gabel, H. E., Jr., Erie Electric Co., Inc., Buffalo, N. Y.
Harpole, M. J., Linde Air Products Co., Buffalo, N. Y.
Maenpaa, W. K., General Railway Signal Co., Rochester, N. Y.
McClennan, J. H., Central N. Y. Power Corp., Syracuse, N. Y.
Pawlikowski, T. A., United Illuminating Co., Bridgeport, Conn.
Svelnis, F. S., Westinghouse Elec. Corp., Boston, Mass.
Walker, F. H., Jr., U. S. Rubber Co., Naugatuck, Conn.
Wrobel, H. T., General Electric Co., Lynn, Mass.

2. Middle Eastern

Baehr, C. A., The Delaware Hospital, Inc., Wilmington, Del.
Bredenberg, A., Jr., General Electric Co., Erie, Pa.
Brown, J. E., Brown & Heim, Inc., Baltimore, Md.
Brunner, J. J., B & M Electric Co., Springfield, Ohio
Cornell, F. J., Ohio Crankshaft Co., Cleveland, Ohio
Cunningham, C. F., Westinghouse Electric Corp., Huntington, W. Va.
Davies, H. H., Ford, Bacon & Davis, Charleston, W. Va.
Davis, R. L., Jr., Navy Material Redistribution Center, Chester, Pa.
Doriot, K. E., Union Switch & Signal Co., Swissvale, Pa.
Eckhardt, D. F., National Advisory Committee for Aeronautics, Cleveland, Ohio
Edgerton, R. O., Dayton Precision Mfg. Co., Dayton, Ohio
Fichter, W. G., Jr., Beth Fairfield Shipyard, Baltimore, Md.
Foley, J. E., Jr., Lt. Col., 5913 N. Leithgow St., Philadelphia, Pa.
Gleason, R. F., Naval Research Laboratory, Washington, D. C.
Greenlee, P. H., Capt. A. C., Wright Field, Dayton, Ohio
Harlepp, R. E., The Ohio Crankshaft Co., Cleveland, Ohio
Hellman, M. H., Air Technical Service Command, Wright Field, Dayton, Ohio
Herwald, S. W., Westinghouse Electric Corp., East Pittsburgh, Pa.
Martin, P. N., Union Switch & Signal Co., Pittsburgh, Pa.
Martinez-Matos, G. A., Firestone Tire & Rubber Co., Akron, Ohio
Nussbaum, R. D., Philadelphia Navy Yard, Philadelphia, Pa.
Maida, F. X., Erie Resistor Corp., Erie, Pa.
Phillips, R. S., Naval Research Lab., Washington, D. C.
Pitts, D. E., Maj., S.C., Office of the Chief Signal Officer, Washington, D. C.
Simpson, J. L., Carbide & Carbon Chemicals Corp., South Charleston, W. VA.
Smith, E. J., Brown & Heim, Inc., Baltimore, Md.
Smith, F. O., A. T. & T. Co., Charleston, W. Va.
Stevens, F. F., General Electric Co., Philadelphia, Pa.
Timanus, W. R. (Re-election), Timanus & Feige, Inc., Baltimore, Md.
Weber, J. C. (Re-election), West Virginia University, Morgantown, W. Va.
Wentz, J. K. (Re-election), General Electric Co., Erie, Pa.
Williams, K. M., United Engineers & Constructors, Inc., Philadelphia, Pa.
Wilson, J. E., General Electric Co., Erie, Pa.
Winslow, F. E., General Electric Co., Baltimore, Md.
Zimmerman, R. F., General Motors Corp., Dayton, Ohio

3. New York City

Bernhard, B. (Miss), Sperry Gyroscope Co., Great Neck, N. Y.
Buchman, H. F., Crocker Wheeler E. M. Co., Ampere, N. J.
Button, O. W., Lt. (E)L, USNR, Third Naval District, New York, N. Y.
Dressler, K. B., Consolidated Edison Co., New York, N. Y.
Flanigan, J. P., Lt., U. S. Army Air Corps, c/o P.M., New York, N. Y.
Haskell, J. J., Office of Inspector of Naval Material, New York, N. Y.
Heinrich, P. G., Maintenance Co., New York, N. Y.
Hendrickson, W. W., The Okonite Co., Passaic, N. J.
Lebovici, J. (Re-election), Crocker Wheeler Elec. Mfg. Co., Ampere, N. J.
Misuriello, H. P., Crocker Wheeler Elec. Mfg. Co., Ampere, N. J.
Shen, T. Y., 640 West 153rd St., New York 31, N. Y.
Smith, G. J., War Dept. AAF, ATSC, New York, N. Y.
Stern, R., Eastern States Elec. Contr., Inc., New York, N. Y.

Strough, R. I., Arma Corporation, Brooklyn, N. Y.
Wille, A. J., Bendix Aviation Corp., Teterboro, N. J.

4. Southern

Banic, G. M., Jr., Tennessee Eastman Corp., Knoxville, Tenn.
Bogren, O. T., Florida Portland Cement Co., Tampa, Fla.
Burney, J. E., Alabama Power Company, Birmingham, Ala.
Childs, E. W., Jr., Alabama Power Co., Birmingham, Ala.
Day, A. C., Tennessee Valley Authority, Wilson Dam, Ala.
De Blieux, G. W., New Orleans Public Service, Inc. New Orleans, La.
Easter, E. C., Alabama Power Co., Birmingham, Ala.
Farmer, G. E., Tennessee Valley Authority, Chattanooga, Tenn.
Gordon, L. J., Dade Drydock Corp., Miami, Fla.
Hall, C. W., Tennessee Valley Authority, Knoxville, Tenn.
Harden, H. G., Naval Operating Base, Key West, Fla.
Hazzard, M. R., Alabama Power Co., Birmingham, Ala.
Hill, K. H., Memphis Light, Gas & Water Div., Memphis, Tenn.
Hobson, C., Lt. (jg), USNR, Oak Ridge, Tenn.
Hood, H. R., Capt., U.S.E.D., Oak Ridge, Tenn.
Houser, W. H., Tennessee Eastman Corp., Oak Ridge, Tenn.
Keenan, K. E., Memphis Power & Light Co., Memphis, Tenn.
Knudsen, K. P., Jr., Wheelco Instruments Co., Atlanta, Ga.
LaCook, G. C., Carbide & Carbon Chemical Corp., Oak Ridge, Tenn.
Latimer, J., Tennessee Valley Authority, Chattanooga, Tenn.
Morris, L. H. (Re-election), General Electric Supply Corp., Richmond, Va.
Potter, B. F., Duke Power Co., Durham, N. C.
Reed, R. B. Lt., U. S. Navy, Salyersville, Ky.
Seale, M. J., Alabama Power Co., Birmingham, Ala.
Spracher, P. R., Virginia Electric & Power Co., Richmond, Va.
Stanton, S. S., Standard Oil Co. of N. J., Baton Rouge, La.
Strahan, R. L., Mathieson Alkali Works, Inc., Lake Charles, La.
Upson, N. W., Graybar Electric Co., Miami, Fla.
Pardell, M. K., A C Spark Plug Div., G.M.C., Flint, Mich.
Piercy, W. E. (Re-election), Republic Steel Corp., Chicago, Ill.
Reinke, M. C., Dow Chemical Co., Midland, Mich.
Rigert, M., Kyle Corp., South Milwaukee, Wis.
Savage, H., Commonwealth Edison Co., Chicago, Ill.
Scharfenberg, H. E., Chrysler Corp., Highland Park, Mich.
Yeakle, T. W., Russell Electric Co., Chicago, Ill.

5. Great Lakes

Becker, E. C., Commonwealth Edison Co., Chicago, Ill.
Bodley, E. A., Northern Indiana Public Service Co., Hammond, Ind.
Bonnet, R. W., Duncan Electric Mfg. Co., Lafayette, Ind.
Boroviak, E. T., Northern Ind. Public Service Co., Hammond, Ind.
Corrin, A. S., Commonwealth Edison Co., Chicago, Ill.
Gaut, R. E., Commonwealth Edison Co., Chicago, Ill.
Getchell, E., Commonwealth Edison Co., Chicago, Ill.
Gougler, R. L., Illinois Bell Tel. Co., Chicago, Ill.
Greiner, A. C., Square D Company, Milwaukee, Wis.
Gustafson, C. W., General Electric X-ray Corp., Peoria, Ill.
Hau, L. J., (Re-election), Commonwealth Edison Co., Chicago, Ill.
Hawke, F. T., Seeger-Sunbeam Corp., Evansville, Ind.
Johnson, J. V., Carnegie Illinois Steel Corp., Chicago, Ill.
LaFrenz, A., Corn Products Refining Co., Pekin, Ill.
Mercier, F. E. (Re-election), Commonwealth Edison Corp., Chicago, Ill.
Metcalf, R. K., Illinois Bell Tel. Co., Chicago, Ill.
Moore, J. B., Northern Indiana Public Service Co., Gary, Ind.
Murphy, R. W., Murphy & Dickey, Chicago, Ill.
White, D. A., The Okonite Co., Birmingham, Ala.
Whyte, C. B., Cities Service Refining Corp., Lake Charles, La.
Wilson, D. C., MAW, Inc., Lake Charles, La.

6. North Central

Abernethy, R. T., Capt., Ordnance Dept., U. S. Army, Lincoln, Neb.
Strelesky, H. J., Mt. States Tel. & Teleg. Co., Denver, Colo.
Veach, C. F., Raymond H. Reed Engg. Co., Columbus, Nebr.

7. South West

Adams, W. F., A & M College, College Station, Tex.
Beaudreau, N. W., Central Power & Light Co., Corpus Christi, Tex.
Boyer, J. T., Jr., Radio Station WNAD, Norman, Okla.
Cutlip, S. S., J. E. Murray Co., Kansas City, Mo.
Dale, R. H., The Cooper-Bessemer Corp., Houston, Tex.
Eaton, H. W., Rural Electrification Administration, St. Louis, Mo.
Farris, G. G., Lt., Air Corps, Kelly Field, Tex.
Gray, D. E., Texas Electric Service Co., Fort Worth, Tex.
Jones, F. W., Gulf States Utilities Co., Beaumont, Tex.
Nabholz, J. P., A. & J. Electric Shop, Little Rock, Ark.
Nott, L. W., Gulf States Utilities Co., Port Arthur, Tex.
Owens, D. L., Humble Pipeline Company, Houston, Tex.
Paton, R., Houston Lighting and Power Co., Houston, Tex.
Pierson, T. H., B. F. Goodrich Co., Port Neches, Tex.
St. Pierre, S. S., Southwestern Bell Tel. Co., Norman, Okla.
Willison, G. G., 306 West Bldg., Houston, Tex.

8. Pacific

Barrows, H. A., Calif. Water & Tel. Co., Monrovia, Calif.
Brinton, R. L., Pacific Gas & Electric Co., San Francisco, Calif.
Buck, A. G., National Adv. Comm. for Aeronautics, Moffett Field, Calif.
Chamberlin, P., Leach Relay Co., Los Angeles, Calif.
Fredrickson, M. O., Dept. of Water & Power, Los Angeles, Calif.
Grabendike, C. A., Calif. Elec. Power Co., Riverside, Calif.
Kimble, J., Harvey Machine Co., Los Angeles, Calif.
Lee, L. L., Jr., Consolidated-Vultee Aircraft Corp., San Diego, Calif.
Logan, J. P., Westinghouse Elec. Corp., Los Angeles, Calif.
Neff, A. J., Bureau of Power & Light, Boulder City, Nev.
Ogilvie, H. W., General Electric Co., San Francisco, Calif.
Parenti, D., Bethlehem Steel Corp., San Francisco, Calif.
Reischel, H. F., Dept. of Water & Power, Los Angeles, Calif.
Rochholz, C. A., Calif. Elec. Power Co., Riverside, Calif.
Schulze, R. P. (Re-election), Calif. State Bd. of Equal., Sacramento, Calif.
Sebrell, E. W., General Electric Co., San Francisco, Calif.
Shenton, R., The Pacific Tel. & Tel. Co., San Francisco, Calif.
Stanford, V. C., Westinghouse Elec. Corp., Los Angeles, Calif.
Wahrenbrock, O. K., Cmdr., USNR, San Diego, Calif.
Wills, G. E., Newbery Electric Corp., Los Angeles, Calif.

9. North West

Bird, R. E., Boeing Aircraft Co., Seattle, Wash.
Brigham, F. W. (Re-election), The Pacific Tel. & Tel. Co., Seattle, Wash.
Kinkade, V., Boeing Aircraft, Seattle, Wash.
Messenger, U. H., The Pacific Tel & Tel. Co., Portland, Oreg.
Paine, E. A. (Re-election), Portland General Electric Co., Portland, Oreg.
Potter, V. G., Boeing Aircraft Co., Seattle, Wash.
Sherman, G. E., Bonneville Power Administration, Spokane, Wash.
Thompson, L. E., Westinghouse Elec. Corp., Portland, Oreg.
Williams, E. E., Bonneville Power Administration, Portland, Oreg.

10. Canada

Gallimore, G. H., Canadian Signal Corps, Toronto, Ont., Can.
Pavlasek, T. J. F., RCA-Victor Co. Ltd., Montreal, Que., Can.
Rowan, W. O., Elec. Lt., RCNVR, Naval Service Headquarters, Ottawa, Ont., Can.
Staines, G. J. R. L., (Re-election), Hydro-Electric Power Comm. of Ont., Toronto, Ont., Can.
Sutton, A. L., Turbo Research, Ltd., Leaside, Ont., Can.

Elsewhere

Dunne, A. D., Electrical Apparatus Co., Ltd., St. Alban, Herts, England
Heald, D. W., Admiralty Signal Establishment, Manchester, England
Jackson, E. W., Bahrein Petroleum Co., Bahrein Island, Persian Gulf
Lester, S., Brush Electric Engineering Co., Loughborough, Leics., England
Perry, J., British Thomson-Houston Co., Ltd., Rugby, Warwickshire, England
Scott-Smith, H. M., Messrs. A. Reyrolle & Co., Ltd., Hebburn, England
Thompson, N., Richard Thomas & Baldwins Ltd., Monmouthshire, England
Tuovinen, E. J., Haarlan Sellulosayhtio, Lievestuore, Finland
White, R. L., Brush Elec. Engg. Co., Ltd., Loughborough, Leics., England

Total to grade of Associate

United States and Canada, 171
Elsewhere, 9

OF CURRENT INTEREST

Trends in Research Viewed by Prominent Members

Probable future trends in the sponsorship of research were discussed during a review of the history of research and its future course by two Honorary Members of the Institute at a meeting of the AIEE New York Section, December 5, 1945. Doctors Gano Dunn (HM '45) and F. B. Jewett (HM '45), both AIEE past presidents, presented their views of the value of research and pending legislation pertaining to its support and control.

HISTORY TRACED BY DOCTOR DUNN

Doctor Dunn discussed the certainty of the fruitfulness of research and its evolution from a comparatively unproductive early period to its present fertile stage. He observed:

"About the time of the foundation of the American Institute of Electrical Engineers in 1884, the phrase 'electricity is only in its infancy' was on everybody's lips. By the 1890's, however, the development of the telephone, the quadruplex telegraph, the early d-c electric motors, the incandescent lamp and storage batteries, and other such things, caused members of the AIEE to become 'fed up' with the statement for electricity had grown to 'maturity.' About this same time Michelsen announced that most of the fundamental laws of physics had been discovered and that any future advances in physics probably would revolve around refinements in the third decimal place. All this was before the electron had been identified.

"And then suddenly, about 50 years ago, came the discovery of X rays and all the other wonderful things that followed in its train. With these remarkable early items of progress, and with the recent unveiling of many really startling developments kept secret for reasons of war, we have a mass of invention and discovery, compared with which that prior to 1900 is quantitatively insignificant."

In his review of early research history Doctor Dunn spoke of the prejudice, as late as 1888 when he entered electrical engineering school, against engineering "theory." In many instances in England, as well as in the United States, engineering students had to conceal their studies because industrial employers did not want men whose training was what then was called "theoretical."

"But today," he continued, "the appetite of industry for theoretically trained engineers is insatiable because the results of research are so certain and so profitable that no great industry can live without it. The fruitfulness of research grows in geometrical proportion with the extent of its application, because the weapon of research is knowledge, and each item of new knowledge, valuable in itself, sheds light not only on the path directly in front of it, but on the paths on each side of it. This holds true not only in basic scientific research but in applied science and development."

Doctor Dunn confessed to an affection for the term "pure science" because it describes that type of investigation which pursues knowledge for its own sake rather than for its utilitarian value. It is this type of research that led to Farraday's discovery of the means of producing electricity by mechanical power and that led him to resent Gladstone's inquiry as to its use. Farraday is said to have replied, "My Lord, some day you will be able to tax it." Doctor Dunn emphasized the fact, however, that research of any type subscribes to the principle, "Seek and ye shall find." This principle finds its quantitative expression in the mathematics of probabilities, the doctrine of chances.

"In the early days," Doctor Dunn said, "when the facilities and money for research in pure science in the universities and the appropriations for research in industries were limited and fitful, the probabilities of results were small and discouraging. But when research in the larger industries with adequate resources became an attack along a whole front, the results were unfailing, and to such an extent that millions annually were poured into the laboratories. As a case in point, the expenditure of possibly half a million dollars in research on the vacuum tubes used in telephone repeaters resulted in savings to the operating companies of more than ten million dollars per year resulting in reduced cost and improved quality of service to the public."

Doctor Dunn pointed out that the hundreds of millions of dollars expended for research during the war have been so productive that Doctor Vannevar Bush (F '24) director of the Office of Scientific Research and Development, recommended to the President that the Government subsidize research in an extensive program calling for an expenditure of 33 million dollars during the first year with a subsequent increase to 122 million dollars per year by the fifth year.

He declared:

"While the research with which we have been dealing has had in view principally research in the physical and chemical sciences, the principle of the certainty of the fruitfulness of research applies equally to the biological sciences. There are those who believe that if an attack be made to the same extent along an equally wide front on the scourges of cancer and tuberculosis, their banishment will be accomplished with the same certainty that has brought forth radar, television, and the electron microscope in the field of electronics.

"It is the certainty of the fruitfulness of research," Doctor Dunn concluded, "that has made it a necessity in the industrial world today."

DOCTOR JEWETT DISCUSSES LEGISLATION

Doctor Jewett's extemporaneous comments on the problems in the support of postwar research were concerned primarily with certain bills now before the Congress which contemplate Federal support of research through tax-acquired money. According to Doctor Jewett:

"The genesis of these bills in the main, when one looks back on it, is found to be predicated on the rather astounding success of the Office of Scientific Research and Development under Doctor Bush during the war years, and the assumption that that success can be maintained in the postwar years, assuming that they are peaceful years, on a moderate scale by somewhat similar methods."

Doctor Jewett deplored the inclusion of the word "research" in the title of the organization in question, stating that, although OSRD was extremely successful in mobilizing the entire scientific and technical manpower and facilities of the nation on the industrial research problem of the instruments and instrumentalities of warfare, it did practically no research work of a fundamental character.

"It is completely fallacious," Doctor Jewett said, "to draw any conclusions that what has been done under the impulse of war can be applied in a postwar period. The fallacy of attempting to do so resides in the fact that war itself, complicated and huge global war, as far as science and technology are concerned, is essentially a very simple thing. There are some very definite objectives to be reached but, so far as increasing the total volume of knowledge is involved, that is not considered."

Doctor Jewett ascribes to the success of OSRD the present interest in Government subsidies for research, first evidenced by the Kilgore Bill. This bill advocates the formation of a special agency, to be known as the National Science Foundation, which is to be financed by annual appropriations from the Congress. It covers not only the physical, biological, and medical sciences but political and social sciences as well. The bill contemplates fellowships, possible doctoral fellowships, the allocation of money to institutions of learning to enlarge their de-

partments of science and technology. It also covers support of actual research projects as is determined to be necessary by the board and its director.

Other more specialized bills have been introduced by Senators Byrd, Fulbright, and Magnuson. The latter's proposal is an implementation of Doctor Bush's recommendation, the organization of a national research agency with a minimum of the disadvantages of political control. Such an agency would be administered by a board of distinguished men—scientists and others—to be designated by the President and confirmed by the Senate. In regard to these bills Doctor Jewett said:

"The conflict in Congress is between the proponents of the Kilgore Bill and those of the Magnuson Bill . . . so that, in effect, all of us who have been asked to testify have been asked to compare two types of bills with single objective, Government support of fundamental research, and have not been given an opportunity to discuss what should be the real issue: Whether or not this is a field which Government should invade via the tax collector's office.

"There is a wide difference of opinion on the issue," Doctor Jewett admitted. "Probably a pretty good case can be presented in support of the fact that more money should be spent in the field of science in the postwar years than has been spent in the past. So far as I can see, however, there are no convincing reasons for the assumption that an extension of our tried and established method will fail and that the only alternative is to go to the European method of a controlled-state type of support."

Doctor Jewett did not agree that the Congress must appropriate large sums of money for research under Government control in order to keep pace with other nations. For confirmation he pointed to the success of American research during the war, the climax of a history of private support of science and technology. He felt also that the allocation of funds collected through taxes and distributed through a political agency are likely to be subject to influences that are not strictly scientific and are likely to be restricted by political interests.

With these considerations in mind Doctor Jewett asserted that:

" . . . if either of these bills is passed it will represent a serious and fundamental change from an established method which has been in operation for 150 years. While, at the moment, the matter is of primary interest to fundamental science it should be of interest to everybody concerned with research, particularly to those of us in the technical field who are concerned with the abnegation of science, because it would mark a radical departure from the course which we have followed in the past and advance us further on the road toward a planned state. Ultimately, we may discover that there is no alternative but so far there is no valid proof that Government control of research is desirable. It is a matter which should not be acted upon hastily but which deserves a great deal more discussion than has been given to it."

In reference to a proposed combination of civil and military research, Doctor Jewett contrasted the open stockpile of fundamental science from which the world might draw for civil technological purposes with the necessity for secrecy for military knowledge.

" . . . if you try to lump the effort of military science and the bigger effort of civil science together under a common control," he stated, "what you are doing in effect is asking men to draw a curtain down through their brains. On one side of the curtain their brain cells operate in the field of free publication, free interchange of ideas, and so forth, and on the other side they act in secrecy. I personally doubt that this is a humanly possible thing to do."

In closing Doctor Jewett offered one further objection to the bills, the fact that they provide for too great a variety of causes to be administered by any one small unit.

"I just cannot see," he concluded, "how any small group of men working as a Government agency can administer the money (Congressional appropriations for research) and administer it as wisely as the same amount of money has been administered through the tried and true processes which have tended to make us great as a nation of science and technology."

Construction Industry Advisory Council Meets

The first meeting of the Construction Industry Advisory Council of the Chamber of Commerce of the United States, called by Eric Johnston to consider what can be done now to stimulate construction and to offset inflationary pressures on prices, was held in Washington, D. C., November 1, 1945. Approximately 230 persons including representatives of 95 trade and professional organizations including AIEE, heard E. O. Shreve (A '05), vice-president of the General Electric Company, Schenectady, N. Y. explain the objectives of the council. He listed its purposes and scope.

Proceedings of the conference of the council, which was voted a continuing organization, have been published in a 20-page pamphlet by the Chamber of Commerce entitled, "What's Ahead for Construction?"

Deferment in Draft for Science Students

Acting on a request by John W. Snyder, reconversion director, Selective Service recommended to local draft boards November 29, 1945, that they defer registrants who are studying or teaching physical sciences or engineering to increase the scientific knowledge of the United States.

The following registrants were mentioned:

1. Taking advanced studies and working for a master's or doctor's degree in the physical sciences (including mathematics, physics, chemistry, and the engineering courses, including electrical, civil, and mechanical engineering).
2. Teaching physical science or engineering in an accredited college or university.
3. Doing university research in the physical sciences or engineering.

A committee to effect the program was formed by representatives from the Office of Scientific Research and Development, the War and Navy Departments, the Civilian Production Administration, and other Government agencies.

Registrants will be certified by the committee for deferment only if their work contributes "significantly" to the interest of the country, and if they can prove that

Unit Substation for Russia

The first of 15 railway-type distribution substations was constructed by General Electric Company at its Pittsfield (Mass.) plant. It is expected that this unit will be used in the rehabilitation of towns and cities devastated by war. The entire unit substation permanently mounted on a flat car weighs 111,000 pounds, and contains a 46-kv incoming disconnecting switch, oil circuit breaker, lightning arresters, power transformer, and three outgoing 15-kv metal-clad switchgear circuit breakers and feeders. Outgoing cable connections are through the floor of the car.

research would be delayed by inability to carry on their work. Those wishing to be certified must present a notarized statement of their intentions to the Office of War Mobilization and Reconversion, Washington, D. C. They also must present a statement signed by a college or university official certifying that the registrant has been accepted as a candiate for an advanced degree, as a teacher, or as a research worker in physical sciences.

The plan stipulates that any registrant who has completed at least three years of work leading to a bachelor's degree in science may be certified if he has served not less than two years in a project directly connected with the war effort.

Mr. Snyder explained that the plan as enunciated was aimed at developing the technical skills which have been acquired, and to provide adequate teaching facilities for returning veterans who desire to resume their studies in the scientific field.

Recommendations for conservation of scientific personnel were made also by Doctor Vannevar Bush (A '15, F '24) director of Office of Scientific Research and Development in a 184-page report to the White House dated July 1945 and prepared at the request of the late President Roosevelt. It was entitled, "Science, The Endless Frontier." That report (*EE, Sept '45, p 344*) recommends a National Research Foundation established by Congress for the purpose of developing scientific research, encouraging scientific talent in American youth by offering scholarships and fellowships, and promoting long-range research on military matters.

Unregistered Architect Denied Fee. Under a new Minnesota state regulatory law for engineers, architects, and land surveyors, a county court recently denied to a St. Paul architect any damages in an action he brought to collect fees for plans and specifications for an apartment building alteration. The court ruled that the architect was not registered under the new law and therefore could not prepare such plans legally. It is provided under the registration law that the engineer or architect directly responsible for preparation of each drawing in a set of plans must sign that plan as a registered professional engineer or architect, as the case may be. Failure to comply with the law is considered a gross misdemeanor with severe penalties attached. The law became effective January 1.

GE's Miniature Power Plant for Colleges. A miniature power plant, designed to permit study of operations of an industrial or a city standard power plant has been developed by the General Electric Company, Schenectady, N. Y., for use in laboratories of engineering colleges. The complete unit, which weighs approximately 20,000 pounds, stands about six feet in height. It contains two 20-kw steam-turbine generators, a motor with a genuine "load," and other standard equipment.

ASA Elects Officers and Announces Plans

The American Standards Association, at its annual luncheon meeting held in New York, N. Y., December 7, 1945, announced that Henry B. Bryans (F '18) executive vice-president of the Philadelphia (Pa.) Electric Company, had been re-elected to serve a third term as its president; F. R. Lack (M '37) vice-president and manager of the radio division, Western Electric Company, Inc., New York, was announced as incoming vice-president; and Doctor Eugene C. Crittenden (F '44) assistant director of the National Bureau of Standards, Washington, D. C., as the incoming chairman of the Standards Council relieving Doctor Harold S. Osborne (F '21), past president AIEE and chief engineer of the American Telephone and Telegraph Company, New York, who has held the post through the four war years.

Of the 535 Standards adopted by ASA during the past four years, Doctor Osborne reported that some 85 per cent were directly pertinent to war work, about 30 per cent directly for the use of the Armed Forces, 25 per cent for the safety and protection of industrial workers, 30 per cent related to matters vital to the facilitating of large-scale wartime production. The enormity and diversification of wartime industrial production brought vividly to attention the essentiality and the practicability of common standards. Through no other medium could so much have been done in so short a time. This experience is expected to have great and valuable influence in peacetime standards work. One of the noteworthy accomplishments of the year 1945 was the reaching of an agreement with British and Canadian standards representatives for a common standard for Acme screw threads which are used widely in machine tools. The joint standard already has been made an American Standard, and its adoption by British and Canadian Standards associations is expected. Doctor Osborne reported that during 1945 the ASA has associated itself with eight projects under the auspices of the temporary United Nations Standards co-ordinating committee. These projects relate to radio noise interference, grading and testing of shellac, the moisture regain of wool, the definition of the term "rayon," testing of textiles, gauges for metal sheet and wire, high voltages for electric transmission lines, and the heat treatment of steel. He reported that continuance of this work is expected under the permanent international standards organization which now is being formed.

Mr. Bryans reported that ASA already had broadened the potential scope of its work by an appropriate change in its constitution (principally, the elimination of the restrictive phrase "where engineering methods apply") is broadening the representation on its board of directors, and is streamlining its functional procedure for the approval of standards to capitalize upon experiences gained and contacts made during the war years. Mr. Bryans reported that he expected a very great increase in standards work, as the ASA develops its position of the common meeting ground of Government, labor, and private industry, for the development of the standards required for the good of the nation. He contrasted this typically American program with the current trend in Great Britain, France, Belgium, Holland, and other countries, for Government to take the dominant position, even to the nationalization of banks, utilities, and mines.

Mr. Bryans reported that the outstanding problem for the ASA at the present time, in the light of its expected increased activity, is the matter of the increased financial support necessary for the larger responsibility. He announced a two-step plan, the first step aimed at seeking support from a group of the larger companies to carry the main burden over the transition period of perhaps the first two years; the second step to provide for a broadening of the basis of support, to spread the obligation more equitably over a wide range of industry and business.

Research Reduces Aircraft Radio Interference

Charges of static electricity frequently build up to considerable proportions on the fuselage of aircraft while in flight, especially under certain conditions, or in certain areas where weather conditions are conducive. Manifestation of such charges, in so far as aircraft passengers or operating personnel are concerned, is the discharge from propeller tips, wing tips, and other protuberances which gives a *startling* visible flaming effect. More important, however, is the fact that such static discharges commonly cause a complete blackout of radio operation, thus leaving the aircraft isolated from ground communication at critical times. Some 25 per cent or more of all aircraft crashes that have occurred in certain areas of the United States have been traced directly to such failures of radio communications.

For some time the Army and Navy have been conducting joint research on this problem, utilizing an extensive program of test flights all over the North American continent, and utilizing also a huge and specially equipped research-laboratory-hangar in Minneapolis, Minn., where service aircraft rather than models could be tested under a wide range of simulated conditions. These conditions included d-c electric discharges ranging up to 1,200,000 volts and 7 milliamperes, as well as simulated snow storms, sand storms, and windstorms, all of which natural phenomena produce the precipitation static which interferes with aircraft radio operation.

Improvements in the design of radio antennas and circuits for aircraft installation were worked out under these conditions, most notable being the complete insulation of antenna systems to prevent any d-c discharges from leaving the aircraft by way of the radio antenna. The research led also to the development of two

methods of dissipating the static charges from aircraft fuselages. The charges were found to build up to a potential of 400,000 volts or more.

To help dissipate these charges as they leak off the plane into its slip stream, ordinary fuzzy cotton wicks impregnated with a liquid of poor electrical conductivity were mounted on the wing tips and on the tail structure. The other method of relief devised, comprised the neutralization of the free charge, or the changing of its polarity. To accomplish this, a device designed to cause the emergence of a steady flow of droplets of water was mounted near an electrode maintained at a high potential. This arrangement results in the hot water droplets becoming charged by induction and, as they are blown away in the slip stream they leave on the airplane an electrical charge of opposite polarity.

Radio Beams to Supplant Wire Channels of Western Union

Establishment of thousands of superhigh-frequency radio-beam stations on towers across the United States with a large increase in telegraphic-message facilities is a plan announced recently by the Western Union Telegraph Company, New York, N. Y. It is expected that eventually much of the system's 2,300,000 miles of wire channels will be replaced by radio beams. So far only a test channel has been established experimentally between New York and Philadelphia, Pa.

C. B. Jolliffe (M '34) vice-president, Radio Corporation of America's Princeton (N. J.) laboratories, which developed the basic radio apparatus and licensed the Western Union Company to use it, said that the radio channel plan was "one of the most significant in communications in modern times, climaxing more than 20 years of research and development."

In the test circuit between New York and Philadelphia ordinary poles and wires are replaced by a chain of elevated radio relay stations spaced 25 to 50 miles apart. Each station receives the transmissions from the preceding station and automatically passes them on to the next following station. Installation of two receivers and two transmitters at each station provides for simultaneous two-way operation.

The new type equipment operates on frequencies in the band of 3,900–4,450 megacycles. As a complement to the use of these high frequencies engineers of the Radio Corporation developed an entirely new system of "modulating" the carrier signal. In this system the carrier is only partially demodulated at each station, thereby avoiding the increase in noise level which would otherwise occur. As a result, the distortion and noise levels are very low even for a chain of many stations.

The test circuit using the new microwave system was installed between New York and Camden, N. J., early in 1945. The band or channel width transmitted by the present system is 150 kilocycles.

Ontario Studying Change From 25- to 60-Cycle Power

A study of the feasibility of changing the 25-cycle power system of Southern Ontario to a 60-cycle system is being made by the Hydro-Electric Power Commission of Ontario, Canada. With a probable increase in electric-generating capacity in the postwar period, there is some question as to whether additional 25-cycle capacity should be provided, or whether this is the opportune time to bring in new capacity at 60 cycles and gradually convert all but a part of the heavy industrial concentrations from the present 25-cycle to 60-cycle operation.

The Southwestern Ontario area constitutes the only major 25-cycle power area on the North American continent. The history of this system stems back to 1895. The first of the Niagara Falls hydroelectric stations was developed with generators designed to operate at 25 cycles per second as a compromise between the then ardent proponents of $16^2/_3$ cycles per second, and the then Westinghouse standard of 30 cycles for power and heavy industrial use. The system has grown in the intervening years to a capacity of approximately a million horsepower, approximately 90 per cent of which is generated in the Niagara Falls area, and approximately 50 per cent of which is utilized in the Toronto area. The present 25-cycle generating capacity represents approximately two thirds of the electric generating capacity of the Hydro-Electric Power Commission system, and approximately 10 per cent of the total electric power currently developed in Canada. The investment in the 25-cycle power supply system is approximately $200,000,000.

500-Kv Power Transmission Test Line Being Planned

The American Gas and Electric Service Corporation, New York, N. Y., is planning an investigation of the problem of transmitting power at voltages as high as 500,000 volts. According to the announcement of Philip Sporn (F '30), executive vice-president and chief engineer of the company, the intention is to erect for test purposes 2 3-phase power lines adjacent to the Tidd generating station of the Ohio Power Company at Brilliant, Ohio.

The project will be undertaken in co-operation with the following nine manufacturers:

Westinghouse Electric Corporation
General Electric Company
American Bridge Company
Aluminum Company of America
Anaconda Wire and Cable Company
General Cable Corporation
Phelps Dodge Copper Products Corporation
Ohio Brass Company
Locke Insulator Corporation

Participating in this work with the Ohio Power Company, will be the other two principal companies of the central system, namely, Appalachian Electric Power Company, and Indiana and Michigan Electric Company. These $1^1/_2$-mile power lines will be so built and equipped that thorough studies can be made of the important factors that control the economic application of transmission voltages higher than 287 kv, the present maximum voltage.

Investigations will be centered about corona loss, radio interference, and insulation co-ordination at high voltages. Tests will be made at voltages from 264 to 500 kv. Such investigations are expected to provide essential data for the design of transmission lines and terminal equipment for the economic transmission of power at these high voltages in the relatively near future.

Construction of transmission lines for voltages in excess of the present maximum operating value (287 kv) is considered technically feasible at this time, based on experience with lower voltage designs. However, lower cost construction is expected to result from the data which will be obtained with the proposed installation, as the extended knowledge should permit more closely evaluating the margins now believed necessary in the selection of conductor diameter, spacing, insulation levels of line, and terminal apparatus.

Résumé on Chemistry in Insulation Research

"Contributions of the Chemist to Insulation Research," a 99-page review of chemical advances in the field of electrical insulation from January 1944 to January 1945, has been prepared by the committee on chemistry of the National Research Council Conference on Electrical Insulation. The various reports along with their authors, are:

Frequency Dependence of the Dielectric Behavior of Matter, O. M. Arnold

Rubber Electrical Insulation, H. C. Crafton

Insulating Paper, W. L. Hawkins

Synthetic Plastic Electrical Insulation, R. F. Boyer and P. C. Woodland

Insulating Oils, C. E. Trautman

Ceramic Electrical Insulation, H. Thurnauer, J. W. Deaderick, and A. E. Badger

The last published review by the committee on chemistry (*EE, July '41, p 361*) covered advances in the field of electrical insulation from June 1939 to January 1941.

Copies of the recent review may be obtained from J. D. Piper, The Detroit Edison Company, 2000 Second Avenue, Detroit 26, Mich.

February 1 Deadline for Fellowships. The closing date for applications for the predoctoral fellowships in the natural sciences, which are being administered by the National Research Council under a grant from the Rockefeller Foundation, is February 1, 1946. These fellowships as announced (*EE, Nov '45, p 417*) are to assist young men and women whose graduate training to complete their work for the doctorate in the natural sciences was prevented or interrupted by their war activities.

JOINT ACTIVITIES

Societies Jointly Study Engineers' Economic Status

Engineers Joint Council's committee on the economic status of the engineer has been making studies and surveys on the general problem of the economic status of the engineer. This joint movement is the logical outgrowth of actions that have been taken previously by the individual societies to study such topics as collective bargaining in its relation to the engineering profession, pay scales for engineers, and questions pertinent to the engineer's economic status.

The committee on the economic status of the engineer is composed of representatives appointed by American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Mining Engineers, American Institute of Chemical Engineers, and AIEE. The functions of this committee are solely investigational and advisory. Under the aegis of this committee are three study or survey committees each dealing with a specific phase of the general problem of the economic status of the engineer. The personnel of these committees with their objectives are given herewith.

Economic Status of the Engineer

I. Melville Stein, *chairman*, Leeds and Northrup Company, 4901 Stenton Avenue, Philadelphia, Pa. .... AIEE
W. N. Carey, *vice-chairman* .... ASCE
P. T. Onderdonk, secretary, Consolidated Edison Company of New York, 4 Irving Place, New York 3, N. Y. .... ASME
E. G. Bailey .... ASME
L. W. Bass .... AIChE
J. M. Church .... AIChE
L. J. Fletcher .... ASME
F. B. Foley .... AIME
C. S. Procter .... ASCE
E. J. Stocking .... ASCE
A. C. Streamer .... AIEE
S. Turner .... AIME
S. L. Tyler .... AIChE
E. P. Yerkes .... AIEE
L. E. Young .... AIME

Survey Committees

1. Employer Practice

E. G. Bailey, *chairman*, Babcock and Wilcox Company, 85 Liberty Street, New York 6, N. Y. .... ASME
L. W. Bass .... AIChE
W. N. Carey .... ASCE
F. B. Foley .... AIME
R. C. Muir .... AIEE
H. T. Woolson .... ASME

The objective of the committee for survey of employer practice regarding engineering graduates is to learn directly from a substantial, but carefully selected, representative group of industrial employers, company policies and attitudes pertaining to the selection, training, placement, advancement, guidance, and professional activities of graduate engineering employees. The specific matter of compensation is not a function of this survey committee.

2. Engineering Profession

W. N. Carey, *chairman*, American Society of Civil Engineers, 33 West 39th Street, New York 18, N. Y. .... ASCE
L. W. Bass .... AIChE
E. G. Bailey .... ASME
Mark Eldredge .... AIEE
E. W. Ellis .... AIME

The objective of the committee on survey of the engineering profession is to obtain directly, through a questionnaire to about 100,000 member engineers, specific facts which reflect the economic status of engineers. By means of a precoded series of questions, data will be obtained covering educational levels, years engaged in practice, branch of engineering, field of specialization, annual income, and similar information. These data will be analyzed by an expert consultant and a report made ready for publication and distribution to all members of the co-operating societies.

3. Collective Bargaining

E. P. Yerkes, *chairman*, Bell Telephone Company of Pennsylvania, 1835 Arch Street, Philadelphia 3, Pa. .... AIEE
W. N. Carey .... ASCE
J. M. Church .... AIChE
C. S. Gotwals .... ASME
L. E. Young .... AIME

The objective of the survey committee on collective bargaining by engineers in professional work is to study and report on the problem of collective bargaining as it affects, or may affect, engineers in professional work and in training for professional work. The committee hopes that all members of the five co-operating societies, particularly the employee members, will read the recent AIEE tentative report, "Collective Bargaining and Related Matters" and will send in comments. Neither this survey committee, nor the committee on the economic status of the engineer, endorses or rejects the AIEE tentative report. It is hoped that the AIEE report will serve to inform the members of the five societies of the questions involved, and thus better enable them to submit helpful comments. When this survey committee has obtained sufficient information and comment, it will prepare its own report on collective bargaining. This committee proposes also to work co-operatively with a committee of AIEE which, with the help of a competent consultant, now is compiling a manual on this subject. It is hoped that the manuscript of this manual can be made the basis of a manual to be accepted and published jointly by the co-operating societies.

United Engineering Trustees, Inc., Issues Report

The inadequacy of the 39-year old Engineering Societies Building to meet the present-day requirements of the engineering societies was emphasized again in the annual report of the United Engineering Trustees, Inc., for the year 1944–45 submitted to AIEE and the other participating societies by F. M. Farmer (F '13), president.

A committee of the board made a preliminary exploration of the various alternatives including revamping the present building, acquiring adjacent property, or building on a new site. The services of consulting engineers and architects were retained. The financing of any such project has been prominent in the board's discussions. Several of the smaller associated societies have raised substantial funds for their own individual buildings but UET has been assured that these organizations will be interested in any early plans which may be developed for a real engineering center in which they might be included.

The continued efforts of the finance committees over the past several years to improve the quality of the corporation portfolio has enabled the committee of the past year, with the assistance of the professional financial advisers, to replace with top-grade investments practically every security which had deteriorated, and to maintain an encouraging rate of income for the departments.

The statement for the year covering costs of operating the building and the corporation shows a credit balance of $2,171.86, which compares with a credit of $286.70 for the previous year. This has been effected by the greater use of meeting halls than was anticipated a year ago, and by close attention to expenditures. This has been accomplished, also, despite the higher cost of maintenance materials and the increases in wages of building service employees.

The allocation to which attention was called in last year's report should be noted again, namely, roughly 16 per cent of the total assessments paid by the Founder and Associate Societies goes to depreciation reserve fund of the Engineering Societies Building, 62 per cent to operating the Engineering Societies Building, and 22 per cent to operating United Engineering Trustees, Inc.

Accretions to the depreciation reserve fund for the Engineering Societies Building have continued, the fund having increased during the year by $20,000 from income and by $12,376.59 from interest, so that at the end of the fiscal year the fund amounted to $546,273.91.

The aggregate book value of capital fund investments on September 30, 1945, the close of the fiscal year, was $1,606,-249.46 with a market value about that date of $1,712,211.99, or $106^1/_2$ per cent of book value. This percentage for the preceding annual period was $101^1/_2$ per cent. The general reserve fund, authorized in November 1914 to be maintained at $10,000, has been called upon at various stages, and always restored. During the past year it has been $1,500 with $6,000 added at the end of this year, bringing it to $7,500 now. It should be restored as rapidly as possible to at least $10,000 against emergency.

It now appears, the report continues, that science, engineering, and technology are fields of man's activities which will play a much more prominent part in the great economic progress which is being so widely anticipated in the immediate future. Thus, the number of societies will increase and their memberships will grow. This need for co-ordination will increase steadily among these groups in dealing with nontechnical matters of common concern, such as the collective bargaining

problem and legislation involving engineers and engineering questions.

The engineering profession, it concludes, should present a united and forceful front in dealing with these matters. The report asks, "Should not the trustees in planning for the increased physical facilities that will be required, provide not only a real Engineering Center Building which can house all the principal societies in the engineering fields, but also plan to serve the engineering professions in dealing with these matters of common concern through assisting in the organization of the required agencies and by providing the necessary headquarters and facilities for them?" In other words, the report asks if in addition simply to administering the Engineering Societies Building, they should not help to carry out in other ways the object of the corporation as stated in its charter, namely, "the advancement of the engineering arts and sciences in all their branches."

Engineering Foundation Issues Report on Year's Research Activities, Projects

The Engineering Foundation, established in 1914, completed its 31st fiscal year September 30, 1945, and the chairman's report of the year's activities was presented at its annual meeting by A. L. Queneau to AIEE and the other Founder Societies.

The book value of the capital funds of the Foundation was $984,650 compared with $962,000 on September 30, 1944. The income for the fiscal year 1944–45 was $34,536.89 compared with $35,472.76 for the previous year 1943–44. Disbursements amounted to $28,675.22 compared with $22,750.78 for the year 1943–44. The balance on September 30, 1945, was $46,876.54 compared with $41,014.85 September 30, 1944.

As is its custom the Foundation has supported, during the year, research projects in diverse fields of engineering also certain agencies having as their objective the advancement of the engineering profession. Preference has been given as in the past to projects of a fundamental nature which would not normally be undertaken by an industrial research organization or otherwise, where a group of industries are concerned, the Foundation has merely furnished such support as enabled it to serve as a catalyzing agent for the project whose main support was from industry. In some cases certain parts of a research on a project supported by the Foundation became of specific interest to the war effort and those parts of the problem were taken over or further supported by a Government agency. That is, the Foundation's support of certain broad research projects led to more specific projects which the Government could support.

The adequacy of the Foundation's resources to support a research program cannot be judged by demands made over the past four years. Industry, under conditions of reasonable prosperity, no doubt will support extensive research largely in company laboratories. The Army and Navy seemingly will continue research in fields basic to a state of continued preparedness. To support research of a more general interest and of a scope differing from the afore-mentioned, organizations such as the Foundation can play an important part, but to do this additional funds are necessary.

During the year 1944–45 work under eight projects has continued. Grants for 1945–46 were recommended for continuation of nine projects and for the initiation of two new projects.

Welding Research Council. (Foundation grant $4,000. Chairman, Comfort A. Adams, E. G. Budd Manufacturing Company, Philadelphia, Pa.)

The progress report for the year ending September 30, 1945, states that its more practical investigations have been aimed at securing basic design data rather than the solution of some particular war problem.

With the cessation of hostilities, much of the Government research work has been curtailed and abandoned projects are being examined critically and those of a fundamental nature will be continued by the Council.

The Council notes with some concern that there is a tendency on the part of university laboratories, perhaps brought about by necessity, of including a larger share of the overhead as part of the expense of proposed researches.

The budget for the coming year will probably exceed the quarter million mark of last year for the reasons afore-mentioned and because it is planned to undertake a comprehensive investigation in the pressure vessel field.

Confidential reports were issued during the year dealing with the spot welding of aluminum alloys with particular reference to aircraft structures. A few of these have been published in the *Welding Research Supplement*. These investigations had an important bearing on the application of resistance welding to aircraft structures. Specifically the development of methods of cleaning aluminum in preparation for spot welding have been of the greatest significance.

Probably the two most vital problems still confronting the welding industry are those of weldability and residual stresses.

The highlight of the coming year's activities is the organization of a comprehensive pressure vessel research program covering materials, design, fabrication and inspection and testing of pressure vessels. It is estimated that this work will continue for a number of years with the initial program amounting to about $75,000 a year.

Aircraft Committee (Chairman, G. S. Milhalapov)—The Welding Research Council's aircraft committee have carried out important investigations which have led to conservative use of welding in speeding up aircraft production. Most of this work has been done at Rensselaer Polytechnic Institute, Troy, N. Y., California Institute of Technology, Pasadena, and Battelle Memorial Institute, Columbus, Ohio. The work at these research centers has been supplemented with the research work done in a number of aircraft companies, much of it on a co-operative basis.

Fatigue Testing (Structural) Committee (Chairman, Jonathan Jones)—A review by correspondence only, of the report on fatigue strength of fillet, plug and slot welds was made. The report was published in *Welding Research Supplement*, July 1945, as No. 4 in the committee's series of reports. It establishes the great inferiority of fillet and plug welds to butt welds in resistance to stresses of frequent alternation and considerable range. The subcommittee on fatigue strength of structural members has held one meeting. The subcommittee on fillet, plug, and slot welds has submitted a program of further work in its field. Jonathan Jones as chairman is now retiring and F. H. Frankland will assume the chairmanship.

High Alloys Committee (Chairman, S. L. Hoyt)—The principal activity has been the work on stress-corrosion at Carnegie Institute of Technology, Pittsburgh, Pa. Based on the exploratory work at Illinois Institute of Technology, Chicago, an advanced program has now been set up, with appropriate amendments and extensions. The work on stress-corrosion has attracted the attention of the International Nickel Company which has appropriated $500 to assist in a study of shot-peening.

Work on corrosion of welded stainless steel joints at Stevens Institute of Technology, Hoboken, N. J., has been held up largely on account of shortage in manpower. Welded specimens have been prepared and work will commence as soon as a suitable investigator is available.

Resistance Welding Committee (Chairman, F. R. Hensel)—At the second meeting held, a basic plan was drawn for the utilization of the technical staff of Rensselaer Polytechnic Institute, Troy, N. Y., on a paid basis for active advisory and consultation activities in furthering resistance welding research. A survey was proposed to investigate probable sources for conducting resistance welding research. As of September 10, 1945, some of the more important activities of the committee were as follows:

1. Collaboration with the university research committee on the project for spot welding of galvanized steel to be conducted at the University of Texas, Austin

2. A project committee to be appointed to draw up a proposed outline for research on the projection welding of mild steel.

3. A program to investigate the fatigue behavior of spot welds in stainless and mild steel.

4. A program to investigate the spot welding characteristics of yellow brass and silicon brass.

5. A meeting of the executive committee to discuss future work which may be carried forward when some of the research centers are relieved of their war projects.

L. C. Bibber was appointed chairman of the Rensselaer Polytechnic Institute project committee. C. B. Smith was appointed a member of the executive committee to represent the West coast interest.

Structural Steel Committee (Chairman, La Motte Grover)—The only project upon which there has been full-time activity during the last year is the National Bureau of Standards project. Part 1 of this project is to investigate the effect of severe constraint against ductile behavior, residual stresses, and other factors, upon the service behavior of a welded steel structure. Part II is to investigate the effects of various joint arrangements as barriers against the propagation of cracks in steel plating. A general description of this entire program was published in *Welding Research Supplement.* Auxiliary tests of the steel material to determine its notch-toughness at various temperatures are being carried out at the Naval Research Laboratory.

University Committee (Chairman, H. C. Boardman)—A list of current research problems was compiled and distributed to the deans of engineering and heads of departments in practically all of the engineering colleges of the country. A few of the other investigations follow:

1. A special project on stress corrosion was started at Illinois Institute of Technology, Chicago.

2. A report covering a series of investigations on the effect of high temperature on the impact properties of welds made with different types of electrodes was concluded at Purdue University, Lafayette, Ind.

Weldability Committee (Chairman, A. B. Kinzel)—Investigations abroad have yielded much valuable information and have resulted in the saving of time and money. These investigations organized under the committee's auspices have been carried out at Lehigh University, Bethlehem, Pa., Rensselaer Polytechnic Institute, Troy, N. Y., Battelle Memorial Institute, Columbus, Ohio, and Massachusetts Institute of Technology, Cambridge. Probably the greatest rate of expenditure ($60,000) has been made at Lehigh University under Government auspices.

Doctor Kinzel who has guided the work of the weldability committee for the past three years, has resigned, and during the coming year the work will be under the general guidance of C. H. Jennings, Westinghouse Electric Corporation.

Weld Stress Committee (Chairman, Everett Chapman)—A comprehensive review of residual stresses, giving the statement of the problem, what is known, and some of the work still remaining to be done was prepared and published in the June 1945 issue of *Welding Research Supplement.* Investigations were laid out at a number of research centers, and the following problems are well under way:

1. Residual stresses produced by various welding procedures—Massachusetts Institute of Technology, Cambridge.

2. Strength and ductility of steel under conditions of multiaxial tension, Case School of Applied Science, Cleveland, Ohio.

3. Hemispherical shells subjected to static pressure, Pennsylvania State College, State College.

4. Biaxial fatigue studies, Illinois Institute of Technology, Chicago.

In addition, work is about to begin on the following:

1. Residual stresses under biaxial and triaxial conditions—The use of high-speed rotating disks, Massachusetts Institute of Technology.

2. Studies of the flow, fracture, and relaxation of steels under combined stress at high temperatures, Westinghouse Electric Corporation, East Pittsburgh, Pa.

The annual rate of expenditure is about $50,000. It is expected that this will be increased during the coming year.

LIBRARY

OPERATED jointly by the AIEE and the other Founder Societies, the Engineering Societies Library, 29 West 39th Street, New York 18, N. Y., offers a wide variety of services to members all over the world. Information about these services may be obtained on inquiry to the director.

Engineering Societies Library Reports for 1944–45

The annual report of the Engineering Societies Library for the year 1944–45 was submitted by Harrison W. Craver, director, to AIEE and the other Founder Societies. The cessation of hostilities came so late in the year that it had little effect on the work of the Library which continued at last year's high level of activity. The accompanying tables tell the story of library operation since 1942.

Operation of Library 1944–45

Maintenance revenue	$50,191.58	
Maintenance expenditures	45,153.55	
Credit balance for year 1944–45	5,038.03	
Credit balance from previous years	23,108.67	
Credit balance September 30, 1945		$28,146.70
Service bureau revenue	$39,108.70	
Service bureau expenditures	31,735.49	
Credit balance for year 1944–45	7,373.21	
Credit balance from previous years	15,171.01	
Credit balance September 30, 1945		22,544.22
Total net operating credit balance cumulated to September 30, 1945		$50,690.92

The report states that there are three pressing problems for the Library. One is that the stack space for book storage is entirely full, so that every added book creates a difficulty, another matter is the need for greater income, and the third is the necessity for some plan of retirement for long-term employees.

Library Services

	1942–43	1943–44	1944–45
Visitors	22,260	21,992	19,712
Other users	13,579	15,147	13,205
Total	35,839	37,139	32,917
Photostat orders	3,487	4,029	4,211
Photostat prints made	38,702	53,518	53,143
Telephone inquiries	6,689	6,700	5,557
Borrowers	1,055	1,133	1,156
Books lent	1,393	1,533	1,632
Searches and copies	86	114	106
Translations	30	53	65
Total acquisitions	10,286	8,104	9,293
Books reviewed	420	364	229
Library inventory			
Volumes in library	156,780	158,521	160,030
Maps	7,872	8,392	9,112
Searches	4,565	4,654	4,712
Total	169,216	171,567	173,854

OTHER SOCIETIES

Lighting Handbook of IES in Preparation

Plans for publication of a lighting handbook which will cover every phase of lighting from pure physics to specific lighting recommendations have been announced by the Illuminating Engineering Society, New York, N. Y. According to C. A. Atherton (M '42), development engineer of the Reynolds Metal Company, Louisville, Ky., and chairman of the handbook committee, some 500 pages of text containing the latest information on light sources will be prepared by outstanding authorities in their various respective fields.

It is the aim of the handbook committee that this book become the standard accepted reference work for the entire lighting profession and industry and that it will possess maximum value for engineers, architects, designers, public utility personnel, and many others.

The book will be published in convenient manual size and will be released in October 1946 with an initial printing of 7,000 copies. It will be sold and distributed through official channels of the Illuminating Engineering Society.

Robert W. McKinley, electrical engineer, has been engaged as editor of the forthcoming handbook. The handbook committee includes some members of AIEE. In addition to the chairman of the committee, they are: H. L. Miller (A '38), president, Utilities Engineering Company, Philadelphia, Pa., R. G. Slauer (A '41), manager, applications laboratory, general

engineering department, Sylvania Electric Products, New York, N. Y., and H. O. Warner (M '27), director of electrical engineering, University of Detroit, Detroit, Mich.

Highlights of 1946 IRE Winter Convention

Among the highlights of the winter technical meeting of the Institute of Radio Engineers being held at the Hotel Astor, New York, N. Y., January 23–26, 1946, will be the radio engineering show. This display of 168 exhibits occupying two floors and foyer space in the hotel will give members an understanding of the reconversion program and an opportunity to become acquainted with the newest developments and products of the postwar world in the electronics and radio fields.

IRE and AIEE this year will hold a joint meeting scheduled for January 23 at 8 p.m. at the Engineering Societies Building, 33 West 39th Street, New York, N. Y. To accommodate any overflow attendance, such as occurred at last year's meeting, Doctor Austin Bailey, in charge of arrangements for this joint meeting, announced that plans have been made to install a public address system and to reserve another large meeting room in the same building. It was further reported that a timely address will be delivered at this gathering by a speaker prominent in the electrical and electronics field.

The subjects of the technical sessions include the following: military applications of electronics; frequency modulation and standard broadcasting; circuits and theory; television; radio navigation aids; vacuum tubes; radar; industrial electronics; communication systems and relay lines, and quartz crystals and crystal rectifiers.

Future Meetings of Other Societies

American Association for the Advancement of Science. March 27–29, 1946, St. Louis, Mo.

American Society for Testing Materials. 49th annual meeting. June 24–28, 1946, Buffalo, N. Y.

American Society of Heating and Ventilating Engineers. 52d annual meeting. January 28–30, 1946, New York, N. Y.

Illuminating Engineering Society. National convention. September 18–21, 1946, Quebec, Quebec, Canada.

Institute of Aeronautical Sciences. 14th annual meeting. January 29–31, 1946, New York, N. Y.

Institute of Radio Engineers. Winter technical meeting. January 23–26, 1946, New York, N. Y.

Instrument Society of America. Exhibit and conerence. September 16–20, 1946, Pittsburgh, Pa.

National Association of Corrosion Engineers. Annual meeting and convention. May 7–9, 1946, Kansas City, Mo.

National Metal Congress (including meetings of American Society for Metals, American Welding Society, American Institute of Mining Engineers) February 4–8, 1946, Cleveland, Ohio.

Pennsylvania Electric Association. Winter meeting. February 6–7, 1946, Pittsburgh, Pa. Spring meeting. May 28–29, 1946, Harrisburg, Pa.

IRE Elects Officers

Doctor Frederick B. Llewellyn, consulting engineer of Bell Telephone Laboratories, Summit, N. J., has been elected president of the Institute of Radio Engineers, New York, N. Y., for 1946. He succeeds Doctor William L. Everitt (F '36) head of the department of electrical engineering of the University of Illinois, Urbana.

E. M. Deloraine, president of the International Telecommunication Laboratories New York, N. Y., was elected vice-president. Three directors also were elected: Doctor Walter R. G. Baker (M '41), vice-president of the General Electric Company, Bridgeport, Conn.; D. B. Sinclair (M '45), assistant chief engineer of General Radio Company, Cambridge, Mass.; and V. M. Graham, plant manager of Sylvania Electric Products, Inc., Williamsport, Pa.

SAFETY TOPICS • •

Compiled by the AIEE committee on safety.

"Industrial Safety Tomorrow" is the title of a booklet recently issued by the National Safety Council, which should command the attention of every engineer who is in any way identified with the industrial life of the United States. The booklet presents a report on a program for safety in industry, made by a committee of 51 representing 38 national organizations which had indicated interest in sponsoring such a program for the postwar period. AIEE is represented on the committee by W. R. Smith (F '30) chairman of its committee on safety.

Although it is recognized that only a small percentage of Institute members are specifically charged with the planning and administration of general programs related to industrial accident prevention, experience over the years has shown that the goals toward which safety engineers and safety directors strive can be reached only when there is sincere and enthusiastic personal support of the "cause" by everyone from top executive management down through engineering, operating, and production personnel to the superintendents and foremen in direct contact with the working forces.

INDIVIDUAL EFFORT PAYS

During the war period, under the patriotic urge to "save manpower for warpower," effort to control industrial accidents was intensified everywhere throughout the United States. All concerned—employers, labor groups, Government agencies, insurance carriers, technical and industrial organizations and associations—were evidencing by their actions their appreciation of how vital to the success of the war effort was the conservation of manpower in the war industries. An injured industrial worker was just as truly out of the fight as his brother wounded on the firing line. It was logical to realize that the loss of trained industrial personnel could jeopardize the life of the man at the front because of interrupted production of equipment vital to both offense and defense. As a consequence of this patriotic response fewer workers lost their lives in occupational accidents in 1944 than in 1941 despite increased employment in an intensified industrial program.

Studies of industrial accident statistics show that more than 80 per cent of all accidents involve some element of human failure. It will be evident to one who studies individual cases that present experience comprises a large number of accidents which can be prevented only by the employee himself. This suggests the great importance of educational and training procedures and the need for care in placement so that the employee will be suited to the work operation and the environmental conditions. All of these aspects will demand especial care as returning veterans again assume their places in industry.

DESIGN FOR SAFETY

To the engineer, however, concerned with design of apparatus and equipment, plant arrangement, operation and maintenance and the multitude of items of machinery, tools and facilities which are essential to modern industry, there is presented the opportunity for elimination of hazardous conditions by building safety into the design or arrangement when these are in the developmental stage. It is to the various aspects of this matter that the report directs attention, and the electrical engineer should realize that upon him rests the obligation to see that, in new plants and in those which will be remodeled or reconstructed, full advantage is taken of the opportunity to plan for the utilization of electrical energy, for power, illumination, and the many new purposes for which it is employed, in ways which are in keeping with the best approved safety practices and regulations which have come out of experience.

The report directs attention to the importance of safety standards and codes such as are developed under American Standards Association procedure and to which the Institute contributes through the work of its members on its own Standards and safety committees as well as on sectional and other committees of ASA.

ENGINEERS COULD LEAD

Aggressive leadership and thoroughgoing safety planning are deemed by the committee to be essential if the problems of postwar reconversion and peacetime industrial expansion are to be solved and the wartime level of industrial safety maintained and raised. The engineers of this country can, in their respective spheres of activity, whether concerned with management, engineering, construction, or operation, do much to contribute to the attainment of these objectives.

Copies of "Industrial Safety Tomorrow" can be obtained from C. R. Cox, chairman, committee on postwar preparation for industrial safety, National Safety Council, 20 North Wacker Drive, Chicago 6, Ill.

List of Undergraduate Engineering Curricula Accredited by ECPD as of October 20, 1945*

(Subject to revision. For basis of accrediting see *Electrical Engineering*, December 1938, page 515)

Akron, University of: Electrical, mechanical (industrial and aeronautical options)

Alabama Polytechnic Institute: Civil, electrical, mechanical

Alabama, University of: Aeronautical, civil, electrical, industrial, mechanical, mining

Alaska, University of: Civil, mining (including metallurgical and geological options)

Arizona, University of: Civil, electrical, mechanical, mining

Arkansas, University of: Civil, electrical, mechanical

Brooklyn, Polytechnic Institute of: Chemical (day and 8-year evening), civil[a], electrical[a], mechanical[a]

Brown University: Civil, electrical, mechanical

Bucknell University: Chemical, civil, electrical, mechanical

California Institute of Technology: Aeronautical (5- and 6-year courses), chemical (5-year course), civil, electrical, mechanical

California, University of: Civil, electrical, mechanical, metallurgical (metallurgy), mining, petroleum

Carnegie Institute of Technology: Chemical, civil[a], electrical[a], industrial (management)[a], mechanical[a], metallurgical[a]

Case School of Applied Science: Chemical, civil, electrical, mechanical, metallurgical

Catholic University of America: Aeronautical, architectural, civil, electrical

Cincinnati, University of: Aeronautical, chemical, civil, electrical, mechanical

Citadel, The: Civil

Clarkson College of Technology: Chemical, civil, electrical, mechanical

Clemson Agricultural College: Civil, electrical, mechanical

Colorado School of Mines: Geological, metallurgical, mining, petroleum

Colorado State College: Civil, electrical, mechanical

Colorado, University of: Architectural, civil, electrical, mechanical (includes aeronautical option)

Columbia University[b]: Chemical, civil, electrical, industrial, mechanical, metallurgical, mining

Connecticut, University of: Civil, electrical, mechanical

Cooper Union School of Engineering: Chemical, civil[c], electrical[c], mechanical[c]

Cornell University: Chemical, civil, electrical, industrial (administrative), mechanical

Dartmouth College: Civil

Delaware, University of: Chemical, civil, electrical, mechanical

Denver, University of: Electrical

Detroit, University of: Aeronautical, architectural, chemical, civil, electrical, mechanical

Drexel Institute of Technology: Chemical, civil, electrical, mechanical

Duke University: Civil, electrical, mechanical

Florida, University of: Chemical, civil, electrical, industrial, mechanical

George Washington University: Civil, electrical, mechanical

Georgia School of Technology: Aeronautical, ceramic, chemical (including co-operative curriculum), civil, electrical, mechanical

Harvard University[d]: Civil, communication, electrical, industrial (engineering and business administration), mechanical, metallurgical (physical metallurgy), sanitary

Idaho, University of: Civil, electrical, mechanical, metallurgical (metallurgy), mining (includes geographical option)

Illinois Institute of Technology (Armour College of Engineering)[f]: Chemical, civil, electrical, mechanical

Illinois, University of: Architectural, ceramic (technical option), chemical, civil, railway civil, electrical, railway electrical, general[e], mechanical, railway mechanical, metallurgical, mining

Iowa State College: Agricultural, architectural, ceramic, chemical, civil, electrical, general[e], mechanical

Iowa, State University of: Chemical, civil, electrical, mechanical

Johns Hopkins University: Chemical, civil, electrical, mechanical

Kansas State College: Agricultural, architectural, civil, electrical, mechanical

Kansas, University of: Architectural, civil, electrical, mechanical, mining

Kentucky, University of: Civil, electrical, mechanical, metallurgical, mining

Lafayette College: Civil, electrical, industrial (administrative), mechanical, metallurgical, mining

Lehigh University: Chemical, civil, electrical, industrial, mechanical, metallurgical, mining

Louisiana State University: Chemical, civil, electrical, mechanical, petroleum

Louisville, University of: Chemical, civil, electrical, mechanical

Maine, University of: Civil, electrical, general[e], mechanical

Manhattan College: Civil, electrical

Marquette University: Civil, electrical, mechanical

Maryland, University of: Chemical, civil, electrical, mechanical

Massachusetts Institute of Technology: Aeronautical, building and construction, chemical, civil, electrical, general[e], industrial (business and engineering administration), mechanical, metallurgical (metallurgy), naval architecture and marine engineering (including marine transportation), public health, sanitary

Michigan College of Mining and Technology: Civil, electrical, mechanical, metallurgical, mining

Michigan State College: Civil, electrical, mechanical

Michigan, University of: Aeronautical, chemical, civil, electrical, engineering mechanics, mechanical, metallurgical, naval architecture and marine engineering, transportation

Minnesota, University of: Aeronautical, chemical, civil, electrical, mechanical, metallurgical, mining, petroleum

Mississippi State College: Civil, electrical, mechanical

Missouri School of Mines and Metallurgy: Ceramic, civil, electrical, metallurgical, mining (mine) (including petroleum option)

Missouri, University of: Chemical, civil, electrical, mechanical

Montana School of Mines: Geological, metallurgical, mining

Montana State College: Civil, electrical, mechanical

Nebraska, University of: Agricultural, architectural, civil, electrical, mechanical

Nevada, University of: Electrical, mechanical, mining

New Hampshire, University of: Civil, electrical, mechanical

New Mexico School of Mines: Geological, mining, petroleum

New Mexico College of Agricultural and Mechanical Arts: Civil, electrical, mechanical

New Mexico, University of: Civil, electrical, mechanical

New York, College of the City of[a]: Civil, electrical, mechanical

New York State College of Ceramics (at Alfred University): Ceramic

New York University: Aeronautical, chemical (day and 7-year evening), civil,[a] electrical[a], industrial (administrative), mechanical[a]

Newark College of Engineering: Civil, electrical, mechanical

North Carolina State College: Ceramic, civil, electrical, mechanical

North Dakota Agricultural College: Architectural, mechanical

North Dakota, University of: Civil, electrical, mechanical, mining

Northeastern University: Chemical, civil, electrical, industrial, mechanical

Northwestern University: Civil, electrical, mechanical

Norwich University: Civil, electrical

Notre Dame, University of: Aeronautical, civil, electrical, mechanical, metallurgical (metallurgy)

Ohio State University: Ceramic, chemical, civil, electrical, industrial, mechanical, metallurgical, mining (mine)

Oklahoma Agricultural and Mechanical College: Civil, electrical, industrial, mechanical

Oklahoma, University of: Architectural, chemical, civil, electrical, mechanical, petroleum

Oregon State College: Chemical, civil, electrical, mechanical

Pennsylvania State College: Architectural, ceramic (ceramics), chemical, civil, electrical, fuel technology, industrial, mechanical, metallurgical (metallurgy), mining, petroleum and natural gas, sanitary

Pennsylvania, University of: Chemical, civil, electrical, mechanical

Pittsburgh, University of: Chemical, civil, electrical, industrial, mechanical, metallurgical, mining, petroleum

Explanatory Notes

* With the exception of the chemical engineering curricula, this list is corrected to October 20, 1945, and is subject to continual revision. It applies only to curricula which have been inspected by the committee on engineering schools, whether conducted on the usual plan of operation or on the accelerated plan. At the request of the council of the American Institute of Chemical Engineers, due to the effects of the war upon education in chemical engineering, all accrediting of chemical engineering curricula ceased with the 1943 list. Until such time as reasonably normal educational activities in the chemical engineering fields have been resumed and re-examinations made, no current list for this division of engineering will be published. Those who use this list are cautioned that it does not apply to short intensive programs offered by engineering colleges to meet special war purposes.

(*a*). Accrediting applies to both the day and evening curricula.

(*b*). Accrediting applies to the 4-year and 5-year curricula leading to the bachelor of science degree.

(*c*). Accrediting applies to day and to 6-year evening curricula in the Cooper Union Night School of Engineering as submitted to ECPD.

(*d*). Accrediting applies only to curriculum as submitted to ECPD and upon completion of which a certificate is issued by Harvard University certifying that the student has pursued such a curriculum.

(*e*). The accrediting of a curriculum in general engineering implies satisfactory training in engineering sciences and in the basic subjects pertaining to several fields of engineering; it does not imply the accrediting, as separate curricula, of those component portions of the curriculum such as civil, mechanical, or electrical engineering that are usually offered as complete professional curricula leading to degrees in these particular fields.

(*f*). On July 24, 1940, Illinois Institute of Technology was formed by the consolidation of Armour Institute of Technology and Lewis Institute. Curricula now listed under Illinois Institute of Technology were listed under Armour Institute of Technology before October 24, 1940.

List of Undergraduate Engineering Curricula Accredited by ECPD as of October 20, 1945 (Continued)

Pratt Institute: Electrical, mechanical

Princeton University: Chemical, civil, electrical, mechanical

Purdue University: Aeronautical, chemical, civil, electrical, mechanical, metallurgical

Rensselaer Polytechnic Institute: Aeronautical, chemical, civil, electrical, industrial, mechanical, metallurgical

Rhode Island State College: Civil, electrical, mechanical

Rice Institute: Chemical, civil, electrical, mechanical

Rochester, University of: Chemical, mechanical

Rose Polytechnic Institute: Civil, electrical, mechanical

Rutgers University: Civil, electrical, mechanical, sanitary

Santa Clara, University of: Civil, electrical, mechanical

South Carolina, University of: Civil, electrical

South Dakota State College: Civil, electrical, mechanical

South Dakota State School of Mines: Civil, electrical, general[e], metallurgical, mining

Southern California, University of: Civil, electrical, mechanical, petroleum

Southern Methodist University: Civil, electrical, mechanical

Stanford University: Civil, electrical, mechanical, metallurgical, mining, petroleum

Stevens Institute of Technology: General[e]

Swarthmore College: Civil, electrical, mechanical

Syracuse University: Chemical, civil, electrical, industrial (administrative), mechanical

Tennessee, University of: Chemical, civil, electrical, mechanical

Texas, Agricultural and Mechanical College of: Aeronautical, civil, electrical, mechanical, petroleum (4- and 5-year courses)

Texas Technological College: Civil, electrical, mechanical

Texas, University of: Architectural, chemical, civil, electrical, mechanical, petroleum (petroleum production)

Toledo, University of: General[e]

Tufts College: Civil, electrical, mechanical

Tulane University of Louisiana: Civil, electrical, mechanical

Tulsa, University of: Petroleum (including options in refining and production)

Union College: Civil, electrical

United States Coast Guard Academy: General[e]

Utah State Agricultural College: Civil

Utah, University of: Civil, electrical, mechanical, metallurgical, mining

Vanderbilt University: Civil, electrical, mechanical

Vermont, University of: Civil, electrical, mechanical

Villanova College: Civil, electrical, mechanical

Virginia Military Institute: Civil, electrical

Virginia Polytechnic Institute: Ceramic, chemical, civil, electrical, industrial, mechanical

Virginia, University of: Chemical, civil, electrical, mechanical

Washington, State College of: Architectural, civil, electrical, mechanical (basic option), metallurgical, mining

Washington University: Architectural, civil, electrical, industrial (administrative), mechanical

Washington, University of: Aeronautical, ceramic, chemical, civil, electrical, mechanical, metallurgical, mining

Wayne University: Civil, electrical, mechanical

Webb Institute of Naval Architecture: Naval architecture and marine engineering

West Virginia University: Civil, electrical, mechanical, mining

Wisconsin, University of: Chemical, civil, electrical, mechanical, metallurgical, mining

Worcester Polytechnic Institute: Chemical, civil, electrical, mechanical

Wyoming, University of: Civil, electrical, mechanical

Yale University: Chemical, civil, electrical, mechanical, metallurgical (metallurgy)

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

Engineers and Scientists in Government Service

To the Editor:

Ralph Bennett's article (*EE, Nov '45, p 383–6*) made a strong indictment against the personnel practices of the Federal Government in the employment of scientists and engineers, and implied that the faults claimed in the Federal service are present in all Governmental agencies under Civil Service and that they are necessarily a part of any Civil Service system.

The article appearing, as it does, in the journal of the electrical engineering profession at a time when the City of Detroit is critically short of qualified electrical engineers places an unnecessary burden on the recruiting agency for that jurisdiction—the Detroit Civil Service Commission—and consequently requires an answer.

Many of the charges made while they might apply to the only jurisdiction with which Captain Bennett has had experience are not applicable to the Civil Service system as such and specifically do not apply to the Detroit Civil Service Commission.

The hiring techniques used by the City of Detroit include not only a written examination and an evaluation of academic education, practical training, and experience as indicated on an application form but also in addition, as suggested by Captain Bennett, a personal interview of the applicant by a competent personnel technician and representatives from the city departments for which the hiring is being done. This provides an opportunity for exchange of information between the applicant and his potential employer. Candidates are provided with an opportunity to look into the job situation of the department to which they are being assigned. No applicant is required to accept or refuse placement until he has been afforded an opportunity to discover all available information relative to the position offered.

In addition to the above selection techniques and opportunities for the applicant to acquaint himself with the work situation, no placement is considered completed until the employee has served a probationary period in the actual work situation thereby giving both the employer and the applicant a real opportunity to determine whether or not the applicant and the work situation are suitably matched.

The claim made that persons are hired or promoted only to fill vacancies and that no opportunities exist for persons to "make their own jobs" is likewise inapplicable to the operation techniques of the City of Detroit.

While it is true that for the most part hiring for the City of Detroit, like any other organization, is for the purpose of filling existing vacancies and that many promotions are made for the same reason, many promotions result from the fact that many employees as a result of their own individual initiative have been permitted to carry on their own projects, perform work over and above or outside of the scope of the duties for which they were hired originally, and thereby have changed the position or "made their own jobs."

The Detroit Civil Service Commission has in operation a classification division one of whose major purposes is to review the allocation of positions claimed to have "been made" by the employee and as a result of such reviews, positions constantly are being reallocated.

The training of members of the technical staff of the Detroit Civil Service Commission, which includes some 50 employees in both the examination and classification divisions, hardly can be claimed to be clerical. The staff includes engineers, chemists, accountants, attorneys, sociologists, psychologists, statisticians, journeymen in various trades, and others.

It is believed that the selection and placement techniques used by the Detroit Civil Service Commission compare favorably

with those of private industry and that opportunities for advancement within the Detroit service, while they do not lead to positions of 'captains of industry,' are as generally available to those who can qualify for advancement as they are within private employment.

The facts presented here differ from the experience of one person with one Government agency and are worthy of note mainly to indicate that the evils described by Captain Bennett are not necessary evils of public employment and are not peculiar to nor necessarily typical of Civil Service employment.

No claim is intended in this letter that there is no room for improvement in the Government service but the engineering profession itself should assume part of the responsibility for such improvement. As a first step, it could attempt to direct some of its qualified members towards the Government services instead of prejudicing them against it.

EUGENE SOKOLOV (A '39)

(Senior Personnel Examiner, Civil Service Commission, City of Detroit, Detroit, Mich.)

To the Editor:

I am fully appreciative that the personnel problems involved in the recruiting, selection, placement, promotion, compensation, and retention of professional employees are very serious not only to the various professional groups but also to public personnel agencies and the citizens of the country. Unless adequately and satisfactorily handled these problems will eventually lead to a breakdown of Government services and of democracy. Captain Bennett's article, particularly where certain criticisms are made of the personnel practices and policies of the Federal Government, should not be interpreted by your readers as being other than his observations of a narrow segment of the Federal service under adverse wartime conditions. From my own experiences, not only in the City of Detroit but also with other municipal and state agencies, as well as the Federal Government, itself, I can state categorically that most of his observations under normal peacetime conditions are not true.

Captain Bennett's statement, "Unless this feeling can be alleviated in the minds of those from whom our Governmental employees must be drawn, we shall continue to have difficulty in getting enough superior talent" may or may not be true, but in any event, an article such as he has written will tend to create further recruiting difficulties on the part of Governmental agencies rather than ameliorate the situation.

Both as chief examiner of the Detroit Civil Service Commission and as chairman of a technical committee of the Civil Service Assembly of the United States and Canada, I want to state emphatically that it is my opinion that selection methods in public service, at least by progressive public personnel agencies, are equal at least to those found in private industry. Similarly, unless I am completely misinformed, those private industries with advance personnel programs which are in terms of "red tape" (meaning merely a formalization of procedures) are fast approaching the practices of the more advanced public personnel agencies. I also would like to object to the thought involved in the phrase "trusted and experienced evaluator" in reference to personality evaluators. As a member of another professional group, The American Association for Applied Psychology, I have not discovered any individual of professional standing who will admit to any such implied skill or ability. Considerable research currently is being undertaken in the field of personality appraisal but the literature of the field currently shows that even the best procedures are far from satisfactory. Such technics as are available and have any merit are being used in a majority of the reputable Civil Service Commissions.

Captain Bennett's criticism of pay scales for the higher professional positions of the Civil Service is correct. This situation is deplored by all public personnel agencies. I believe that the professional organizations are in no small part to blame for this situation. The pay scales in public agencies reflect in no small part public attitudes as conveyed to the legislative bodies involved. Where professional organizations ably and adequately have presented the situation to these salary fixing bodies, a measure of justice has been done. Where professional organizations have been apathetic, of course the results have been deplorable.

I am glad to see the AIEE concern itself with personnel problems of the public service. Personnel problems are coming to be an important aspect of the work of most professional organizations and such organizations by such activities can contribute materially to the advance of the professions both in the public service and in private industry. This commission and, I believe, the Civil Service Assembly of the United States and Canada would welcome a fact-finding committee not only from the AIEE but also from other professional organizations to the end that the true situation may be discovered and shortcomings corrected. To repeat, on the adequacy of its professional personnel depends the future of Government and democracy in this country.

D. J. SUBLETTE

(Secretary and chief examiner, Civil Service Commission, City of Detroit, Detroit, Mich.)

To the Editor:

I am pleased to have the comments of D. J. Sublette and Eugene Sokolov on my article entitled, "Engineers and Scientists in Government Service." I have no doubt that there are other Civil Service systems, both municipal and state, which do not suffer from the same or as serious difficulties as I have encountered in the Federal Civil Service in the employment of scientists and engineers. However, my experience, as I pointed out very carefully in the first paragraph of my article, is limited to one operation in one section of one Federal department, and I, therefore, do not feel competent to pass on the virtues or vices of other systems. I can say, however, from a fairly wide acquaintance among American scientists and engineers that the difficulties which I delineated have not been confined entirely to my own observation.

The contributions of Messrs. Sokolov and Sublette indicate that the Civil Service Commission of Detroit has a more effective set of procedures for dealing with these difficulties than does the Federal Government. We shall take steps to study these procedures and attempt to incorporate such improvements as we can into the Federal Service. However, I observe in the second paragraph of Mr. Sokolov's statement that ". . . the City of Detroit is critically short of qualified electrical engineers. . ." which indicates that Detroit also has some difficulty in its competition for superior technical talent.

While Messrs. Sokolov and Sublette contest the accuracy of some of my statements, probably with some truth, since my observations were not based on peacetime experience, it is an incontestible fact now that peace has come that a large fraction of the best talent in three large Government laboratories with which I happen to be fairly well acquainted, is leaving these laboratories for other occupations.

Mr. Sokolov deplores the appearance of my article at this particular time. My intention was to be constructive, and I feel that more harm will continue to result from a lack of understanding of the problems which confront the Government research establishments than will be caused by presenting them.

Mr. Sublette indicates his feeling "that the professional organizations are in no small part to blame" for the situation as to low pay scales for higher professional positions of the Civil Service since such pay scales "reflect in no small part public attitudes as conveyed to the legislative bodies involved." I agree with Mr. Sublette and wish to point out that the publications of technical societies such as *Electrical Engineering* provide an excellent medium for insuring that professional men are made aware of situations which require their attention. Despite the stated effectiveness of the Detroit Civil Service Commission, I do not feel that conditions outlined in my article are unusual to Civil Service organizations.

There is a widespread lack of understanding of the Civil Service and its problems among engineers. Since, as Mr. Sublette points out, our security may depend vitally on the improvement of poor conditions, I feel that it is the responsibility of us who know of such conditions to see that they are delineated for the consideration of all who should be interested.

R. D. BENNETT (F '35)

(Captain, United States Naval Reserve, Naval Ordnance Laboratory, United States Navy Yard, Washington, D. C.)

25th Anniversary of Radiobroadcasting

To the Editor:

Your article in the October 1945 issue, "25th Anniversary of Radiobroadcasting,"

pages 365–6, is another in the long series of misstatements, extending now over the past quarter century, seeking to perpetuate the altogether false and misleading impression that broadcasting began at radio station KDKA with the November national election returns of that year.

As a matter of actual and incontrovertible fact, abundantly recorded in the daily press of the time, and by hundreds of listeners, the election returns of the Wilson-Hughes campaign, in November 1916, were broadcast from the De Forest radiobroadcasting station at Highbridge, New York, N. Y.

Because the audience at that time was necessarily somewhat smaller than existed four years later is no valid reason for the studied refusal on the part of your and many other chroniclers blandly to ignore the fact, apparently so obnoxious to them. The 1916 election broadcast was just as actual and equally genuine as was the 1920, or any subsequent one. Only this one happened to be first by four years, was publicized equally well at the time, and actually did initiate that type of radiobroadcasting. The much-touted one at Pittsburgh did not; and no amount of reiteration of the Westinghouse false claims can alter the historical fact, however obnoxious and distasteful this truth may be to certain publicists.

It was Hitler, I believe, who preached that if a lie is big enough and repeated sufficiently often it becomes truth to the public.

Actual broadcasting was many years older than 1916. I first began this revolutionary procedure in 1907, and sporadically thereafter renewed my efforts as my transmitter was improved—Paris, 1908, New York (Caruso, Mazarin, Martin) 1910, and daily phonograph "concerts" 1915–16, until the threat of war closed all nonmilitary radios.

After the war I resumed, December 1919 to January–February 1920 (until the New York Federal radio inspectors revoked my station's license, stating, "there is no room in the ether for entertainment"); May 1920 to 1921 San Francisco and Berkeley; August 1920, WWJ, Detroit; KDKA—by which time the idea began to captivate the public imagination.

In my 1939 "Souvenir Autograph Album," Doctor Conrad was fair enough to write, "One who also ran!"

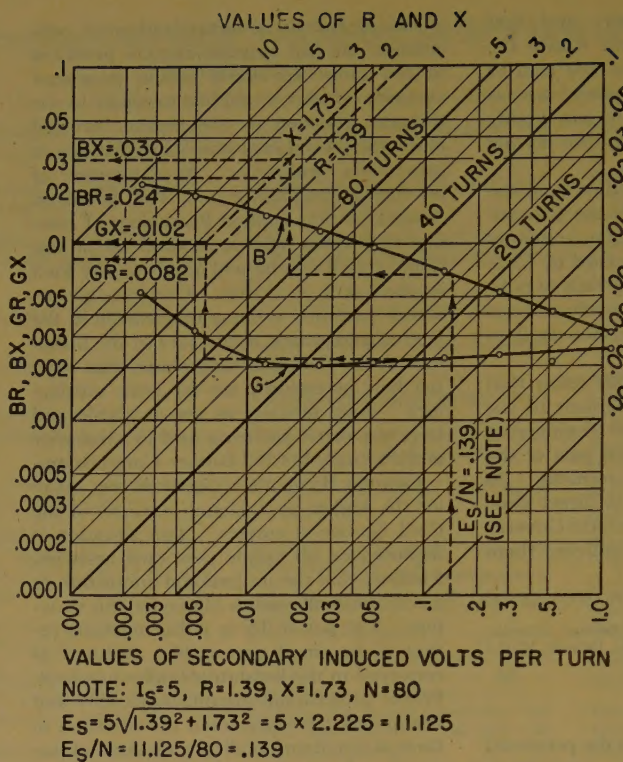
LEE DE FOREST (F' 18)

(Director of Research, Lee De Forest Laboratories, Los Angeles, Calif.)

Field Determination of Current-Transformer Errors by the Secondary-Voltage Method

To the Editor:

Further tests with the secondary-voltage loading method of testing bushing current transformers, described in our paper,[1] have brought out a procedure for greatly reducing the number of calculations required in using the data.



The graphical calculation is carried through for a burden of $R=1.39$ ohms, $X=1.73$ ohms. This corresponds to an NEMA "Z" burden of 50 volt-amperes at 50 per cent lagging power factor. The value, $R=1.39$, includes 0.392 ohm of secondary winding resistance at the 80:1 turn ratio

$$\tan\phi = \frac{BR-GX}{1+BX+GR}$$

$$= \frac{0.024-0.0102}{1+0.030+0.008}$$

$$= \frac{0.0138}{1.038} = 0.0133$$

$\phi = 46$ *minutes,*

$\cos\phi = 0.9999$

$$RCF = \frac{1.038}{0.9999} = 1.038$$

Figure 1. Graph represents the quantities, *B* and *G*, plotted against E_s/N for a multi-ratio 115-kv bushing current transformer at a ratio of 400–5 amperes

A separate regulating transformer is interposed in Figure 1 of the original paper between the 120-volt a-c source and the single-phase phase shifter so as to maintain an even 100 volts on the wattmeter. This simplifies the calculation so that the value of watts, W, and vars, V, read on the wattmeter only need be divided by 100 or moved over two decimal places to be equivalent to the magnetizing component, V/E_v, and loss component, W/E_w, of exciting current.

Susceptance B is equal to $V/(E_vE_s)$ and G is equal to $W/(E_wE_s)$. Quantities B and G may be read directly from the wattmeter for definite values of E_s equal to one, two, and five, or decimals thereof, by providing three scales for the wattmeter.

Whenever E_s is one or a decimal thereof the upper scale is read, when E_s is two or its decimal the middle scale is used, and for E_s equal to five or a decimal of five the lower scale is taken. Also, if the value of E_s is expressed in tenths, the scale factor becomes 0.1; if in units it becomes 0.01, and if in tens it becomes 0.001. Table I summarizes these facts.

With the values of B and G read directly from the wattmeter scale it is apparent that Table I of the original paper may be shortened to Table II of this letter.

Values of B and G then may be plotted against E_s/N on three-cycle log-log paper as in Figure 2.

A special diagonal logarithmic scale is added to the paper as in Figure 1 and values of secondary burden (including winding) resistance, R, and burden reactance, X, are used as co-ordinates. B and G then may be plotted against values of E_s/N and the products BR, BX, GR, and GX may be read directly from the left-hand scale. In this case the vertical co-ordinate for BR, BX, GR, and GX will be one-tenth the value used in plotting the B and G curves. The two columns, B and G in Table II of the original paper, then may be eliminated.

Figure 1 shows a typical graphical solution for the quantities BR, BX, GR, and GX for a 400-5-ampere bushing current transformer. The B and G curves were plotted from test values obtained at a 200-5-ampere ratio. A National Electrical Manufacturers Association "Z"-burden of 50 volt-amperes at 50 per cent lagging power factor, corresponding to $R=1$ and $X=1.73$ ohms, was taken as an example. With the winding resistance of 0.39 ohm the corresponding total secondary impedance is 2.225 ohms. At five amperes the required secondary induced voltage becomes 5×2.225, or 11.125 volts. At 80 secondary turns the required induced secondary voltage per turn becomes 11.125/80 or 0.139 volt per turn.

Table I

E_s	Scale Used	Scale Expansion Factor	Full-Scale Reading	Scale Multiplier
0.1	Upper	1	150	0.1
0.2	Middle	2	75	0.1
0.5	Lower	5	30	0.1
1	Upper	1	150	0.01
2	Middle	2	75	0.01
5	Lower	5	30	0.01
10	Upper	1	150	0.001
20	Middle	2	75	0.001
50	Lower	5	30	0.001

Table II

E_s	$\frac{E_s}{N}$	B	G
0.1	—	—	—
0.2	—	—	—
0.5	—	—	—
1	—	—	—
2	—	—	—
5	—	—	—
10	—	—	—
20	—	—	—
50	—	—	—

A vertical line at $E_s/N=0.139$ intersects the G and B curves as shown. Horizontal lines at the intersection points intersect the 80-turn diagonal as shown. Vertical lines extended at these points intersect the R and X diagonals at values which, when projected to the left margin, are read as values of GR, GX, BR, and BX.

It should be observed that the alignment lines in Figure 1 have been shown dotted. However, in an actual case it is unnecessary to draw these lines as the proper intersection points are found visually or with the aid of a transparent straight-edge ruler extending to the points of intersection. Small pencil dots at these points will preserve them for reference while working through the graph.

The single set of curves of G and B, plotted for the 40-turn connection, make possible the determination of errors for any ratio as long as the value of E_s/N is within the limits of the scale at the bottom of the graph. For those cases in which the horizontal lines, when projected from the intersections of the vertical lines of E_s/N with the B and G curves, fail to intersect the diagonal turn-ratio lines, the values found on the B and G curves may be dropped down to one-tenth the values of B and G and then projected horizontally to the diagonal turn ratio lines. The results in these cases are multiplied by ten. Similarly if vertical lines from the intersections on the diagonal turn-ratio lines fail to intersect the R or X diagonals, one-tenth the value of R or X may be used. The result is again multiplied by ten.

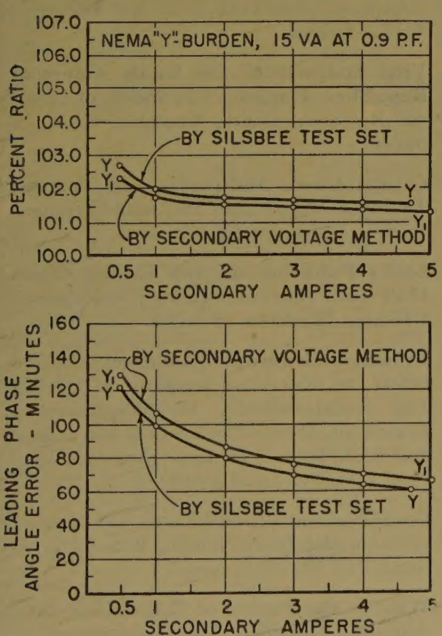


Figure 2. Comparison of the ratio and phase-angle errors of a 115-kv multiratio bushing current transformer, tested at the NEMA Y burden, with a Silsbee test set and by the secondary-voltage loading method

Tests by the latter method were made at a ratio of 200–5 amperes and the data were calculated for the 400–5 ampere ratio (see Figure 1)

Figure 2 shows a comparison of the ratio-correction factors and phase-angle errors for various secondary currents at the NEMA Y burden, as determined by the secondary-voltage loading method and as determined by a Silsbee current-transformer test set.

For small-phase-angle errors, less than $2^1/_2$ degrees, the ratio correction factor is equal to $1+BX+GR$, with an error of less than one-tenth per cent. The phase angle error, ϕ, is determined in terms of its tangent $(BR-GX)/(1+BX+GR)$. It should be noted that for small angles the ratio correction factor, *RCF*, is equal to the denominator of the tangent equation.

E. C. GOODALE (A '27)
J. I. HOLBECK (M '36)

(Bonneville Power Administration, Portland, Oreg.)

REFERENCE

1. Field Determination of Current-Transformer Errors by the Secondary-Voltage Method, **E. C. Goodale, J. I. Holbeck.** AIEE *Transactions*, volume 63, 1944, December section, pages 879–82.

Electrical Essays for Recreation

To the Editor:

Harry Sohon's articles "Electrical Essays for Recreation" published in *Electrical Engineering* appear to be well received, judging from the letters to the editor. The following comments regarding the first two problems as stated in the October issue, page 364, are submitted.

In the first problem (Figure 1) the introduction of a rigid connection between the bent conductor carrying the current and the magnet introduces mechanical forces that neutralize the electrical forces. It becomes the old proposition of a man trying to lift himself by his own bootstraps.

In the second problem (Figure 2) the error comes from assuming that the current in each branch of the double rectifier circuit is five amperes. Each branch conducts only half the time but is carrying full current during the time it is conducting. Since the two branches containing rectifiers never conduct simultaneously, it is the time and not the current that is divided. Thus, the two branch circuits with rectifiers are the equivalent of a single circuit without a rectifier and the full current flows in each rectifier circuit for half the time.

In this connection, a problem, the reverse of Mr. Sohon's problems, is submitted, the problem of an assumption that has been widely accepted but on careful examination proves to be a fallacy.

The rotary-field theory of the single-phase motor is based on the assumption that a single-phase alternating magnetic flux is the resultant of two similar constant-flux components, rotating oppositely and combining vectorially in space. The stored energy in any constant flux is constant and this energy is not affected by the fact that the flux may be rotating. As the stored energy of a rotating constant flux is constant, the combined stored energy of any two rotating constant fluxes must also be constant. Since the stored energy of a single-phase alternating flux varies twice between zero and a maximum in each cycle while the combined energy of any two rotating constant fluxes is constant, a single-phase alternating flux cannot be the resultant of two constant flux components as assumed in the rotary-field single-phase motor theory.

The error in this assumption comes from confusing fluxes that represent energy and follow the laws of energy with magnetomotive forces that represent forces and follow the laws of forces. Since fluxes are energies, according to the law of conservation of energy, they must combine arithmetically and not vectorially. Thus, the resultant of any two constant fluxes is their arithmetical sum, irrespective of the angle at which they merge. However, magnetomotive forces being forces, do combine vectorially in space according to the laws of forces. Assuming that constant fluxes combine vectorially in space in the same manner that magnetomotive forces do lead to inconsistent and incorrect conclusions.

EDWARD BRETCH (M '19)

(Century Electric Company, St. Louis, Mo.)

NEW BOOKS . . .

"Practical Marine Electricity." Written in nontechnical language, and covering the basic principles and techniques of the installation and operation of the electrical equipment found on merchant ships, this is a practical manual, intended for home study as well as for class training. A glossary of electrical terms is included. By S. N. LeCount and H. S. Dusenbery. The Macmillan Company, New York, N. Y., 1945. 258 pages, illustrated, $5^1/_2$ by $8^1/_2$ inches, stiff cardboard, $3.50.

"Essentials of Parliamentary Procedure." Chapters are included on "debate," "voting rank and precedence," and the book is implemented by numerous charts. By (Mrs.) Zoe S. Moore and J. B. Moore. Harper and Brothers, New York, N. Y., 1945. 221 pages, 5 by 8 inches, cloth, $2.50.

"Spherical Trigonometry" (after the Cesàro Method). The Cesàro method offers a novel presentation of spherical trigonometry that ties together the concepts of spherical and plane trigonometry in a

way that enables the student to obtain a working knowledge of the subject in minimum time. By J. D. H. Donnay. Interscience Publishers, Inc., New York, N. Y., 1945. 83 pages, 7 1/2 by 4 3/4 inches, cloth, $1.75.

"Business Journalism, Its Function and Future." This is a source book of information for editors, publishers, advertising agencies, teachers, writers, business leaders, and government officials. Its purpose is to help managers of business papers improve their operations according to the accepted procedures and principles as practiced by the successful business-paper publishing organizations in the United States. Here are explained in detail the relationship of the business press to business, and the relationship of both to society. Some interesting history on the development of the trade press and the specialized press are included. By Julien Elfenbein, Harper and Brothers, New York, N. Y., 1945, 341 pages, price $4.

"The Practical Design of Welded Steel Structures." This book contains information for designers, engineers, and fabricators who use welded construction. Numerous charts to facilitate the design of welded joints and structural members are included, together with discussions of the various welding processes, specifications for electrodes, types of welds, welding positions, qualification tests and inspection. Temperature effects, both physical and metallurgical, have received extended attention, and one section is devoted to the codes of the American Welding Society adopted for most welded construction. By H. M. Priest. American Welding Society, New York, N. Y., 1945, cloth, 150 pages, price $1.

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

PULSED LINEAR NETWORKS. By E. Frank. McGraw-Hill Book Company, New York and London, 1945. 267 pages, illustrated, diagrams, charts, tables, 8 1/2 by 5 1/4 inches, cloth, $3. This is an introduction to electrical transients which puts particular emphasis upon the analysis and operation of linear networks across which rectangular voltage pulses are impressed. Mathematical analysis is confined entirely to differential equations, and the results are correlated closely with the physical phenomena they describe. Fundamentals of circuit operation are stressed and explained in detail.

TABLE OF ARC SIN X. By Mathematical Tables Project, conducted under the sponsorship of National Bureau of Standards. Columbia University Press, New York, 1945. 121 pages, tables, 10 3/4 by 7 1/4 inches, cloth, $3.50. Present volume was begun under the auspices of the Work Projects Administration for the City of New York. This present table of 12-place values of arc sin X, in radian measure, may be regarded as a companion volume to the previously published *Table of Arc tan X*. The function is tabulated at intervals of 0.0001 in the range between 0 and 0.9890, and at intervals of 0.00001 in the range between 0.98900 and unity. A few useful auxiliary tables are included.

ADVANCING FRONTS IN CHEMISTRY, volume 1—High Polymers, edited by S. B. Twiss. Reinhold Publishing Corporation, New York, 1945. 196 pages, illustrated, diagrams, charts, tables, 9 1/4 by 6 inches, cloth, $4. Ten lectures are presented giving a logical development of the recent chemistry of high polymers.

ELECTROLYTIC CAPACITOR. By A. M. Georgiev. Murray Hill Books (technical division), New York and Toronto, 1945. 191 pages, illustrated, diagrams, charts, tables, 9 1/4 by 6 inches, cloth, $3. Author's primary objective is to describe the design, construction, manufacture, function and testing of dry and wet electrolytic capacitors, to explain the operating characteristics of various types, and to indicate both their useful applications and their limitations.

NETWORK ANALYSIS AND FEEDBACK AMPLIFIER DESIGN. By H. W. Bode. D. Van Nostrand Company, New York, 1945. 551 pages, diagrams, charts, tables, 9 1/4 by 6 inches, cloth, $7.50. This book on the design of feedback amplifiers includes an extensive preliminary development of electrical network theory. It also covers nonfeedback amplifiers and miscellaneous transmission problems arising in wide-band systems generally.

OCCUPATIONAL ACCIDENT PREVENTION. By H. H. Judson and J. M. Brown. John Wiley and Sons, New York, N. Y.; Chapman and Hall, London, England, 1944. 234 pages, tables, 8 1/2 by 5 1/2 inches, cloth, $2.75. The object of this reference manual is to present the fundamentals in plant operation which are important in accident prevention. For study purposes the material is arranged in three principal divisions: improvement of work procedures; improvement of plant and equipment; description of the safety organization and related activities. A list of sound-slide films available from the producers or local safety councils is appended.

PRINCIPLES OF RADIO. By K. Henney. Fifth edition, John Wiley and Sons, New York, N. Y.; Chapman and Hall, London, England, 1945. 534 pages, illustrated, diagrams, charts, tables, 8 by 5 1/4 inches, cloth, $3.50. The material is designed for self-study and for the student with little background in radio.

UHF RADIO SIMPLIFIED. By M. S. Kiver. D. Van Nostrand Co., New York, N. Y., 1945. 238 pages, illustrated, diagrams, charts, tables, 8 1/2 by 5 1/2 inches, cloth, $3.25. The concepts of ultrahigh-frequency radio are presented as logical outgrowths of the more familiar low-frequency equipment. The opening chapter provides this transition, while the following chapters successively describe the important pieces of equipment and explain the principles of the production, transmission, and measuring of ultrahigh-frequency currents.

PRINCIPLES OF PHYSICS III, OPTICS. By F. W. Sears. Addison-Wesley Press, Cambridge 42, Mass., 1945. 323 pages, illustrated, 9 1/4 by 6 inches, cloth, $4. This third volume of a series of physics textbooks also emphasizes physical principles. Beginning with the nature and propagation of light, the subject is carried from the general to the specific, concluding with separate treatments of polarization, line spectra, thermal radiation, photometry, and color.

PRACTICAL MANAGEMENT RESEARCH. By A. R. Wiren and C. Heyel. McGraw-Hill Book Company, New York, N. Y., and London, England, 1945. 222 pages, 9 by 5 3/4 inches, cloth $2.50. Discusses the use of scientific research techniques in business, giving in detail the theory, principles, and methods for research into management problems. It describes the analysis of business problems and methods for conducting time studies.

ASTM STANDARDS ON PLASTICS. American Society for Testing Materials, Philadelphia, Pa., 1945. 542 pages, illustrated, 9 by 6 inches, paper, $2.75. This third edition of this compilation contains more than 100 specifications and methods of testing plastics. Twenty-four of these standards apply to plastics in the electrical insulation field.

PERSONNEL RELATIONS. By J. E. Walters. Ronald Press Company, New York, N. Y., 1945. 547 pages, illustrated, 9 1/2 by 6 inches, cloth, $4.50. This book endeavors to set forth both principles and practice in the field of present-day personnel relations. It includes the varying phases of personnel relations as they are determined and influenced by workers in labor unions; managements; the Government; individual employees; labor-management co-operation; and personnel relations techniques and procedures.

PAMPHLETS • • • •

The following recently issued pamphlets may be of interest to readers of "Electrical Engineering." All inquiries should be addressed to the issuers.

Code on Minimum Requirements for Instruction of Welding Operators. (Part A—arc welding of steel 3/16 to 3/4 inch thick), 1945. American Welding Society, New York, N. Y., 83 pages.

The Problem of Reconversion Is the Recovery of Freedom. (Recommendations of the Reconversion Council.) National Association of Manufacturers, New York, N. Y., 11 pages.

Apprentice Training for Returning Servicemen. (A Message to the Men in the Armed Forces.) War Manpower Commission, United States Department of Labor, Washington, D. C., 12 pages.

Diesel Facts (Book One—July 1945). Diesel Engine Manufacturers Association, Chicago 2, Ill., 11 pages.

The Burning Rivers. (Story of Oil in America Before Drilling of Drake Well in 1859.) American Petroleum Institute, New York 20, N. Y., unpaged.

Measurement of Electric Shock Hazard in Radio Equipment. Underwriters' Laboratories, Inc., Chicago, Ill., July 1945, 31 pages.

We Did It This Way. Western Electric Company, New York 7, N. Y., August 1, 1945, 32 pages.

Vital Statistics of the South American Republics. Pan American Society of Tropical Research, Quito, Ecuador, S. A., 4 pages.

Capital Goods Industries and Postwar Taxation. Machinery and Allied Products Institute, Chicago, Ill., 22 pages.

Books Published in the United States 1939–43. American Library Association, Chicago, Ill., 1945, 85 pages.

Economic Planning. (Addresses delivered before the American Academy of Political and Social Science, Philadelphia, Pa., March 30, 1945.) By Ludwig von Mises, and R. S. Tucker, Dynamic America, Inc., New York, N. Y., 24 pages.

Conservation. Pennsylvania Department of Commerce, State Planning Board, Harrisburg, Pa., 1945, 52 pages.

What Is the Future of Television? The American Historical Association (Prepared for the United States Armed Forces), United States Government Printing Office, Washington, D. C., 50 pages.

The Financial Record of the Electric Utility Industry, 1937–44. (A summary compiled from annual reports of the Federal Power Commission entitled "Statistics of Electric Utilities in the United States, $2.) Federal Power Commission, Washington, D. C., November 15, 1945, 14 pages.